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PRICE TRANSMISSION PROCESSES: A STUDY OF PRICE LAGS AND ASYMMETRIC PRICE RESPONSE BEHAVIOR FOR NEW YORK RED DELICIOUS AND MCINTOSH APPLES

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An economic model was developed to gain an understanding of price flows in the markets for New York Red Delicious and New York McIntosh apples. Price transmission processes of two apple products, fresh apples and apple juice, are analyzed and compared. Specific emphasis is placed on evaluating price lags and price asymmetry, two factors which complicate the flow of prices between market levels. Results indicate that retail prices of fresh New York Red Delicious apples and fresh New York McIntosh apples respond more fully to wholesale price increases than wholesale price decreases. Results suggest that wholesale prices of fresh New York Red Delicious and fresh New York McIntosh apples are not determined by shipping point price increases and decreases. Grower price increases and decreases do impact shipping point prices for fresh New York Red Delicious apples. However results are inconclusive for fresh New York McIntosh apples. The results for the apple juice model suggest that forces outside United States apple production, namely increasing imports and increasing efficiency in processing and marketing apple juice, are significant in determining shipping point prices of apple juice.

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TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

SECTION I. INTRODUCTION

Fresh agricultural products are marketed through a three tiered food distribution system involving the transformation and transportation of food between market levels. The relationship between prices at the grower and retail levels is difficult to evaluate because food commodities are transformed through packaging, processing and distribution. Previous empirical studies of fresh fruits and vegetables have addressed issues such as price adjustment asymmetry, causality of price flows, and time lags in price transmission processes (Hall et al., Heien, Ward). However, few studies of commodity pricing mechanisms, particularly in the fresh fruit and vegetable industries, analyze price transmission processes for different levels of the marketing and distribution system within a single industry. This analysis is critical since these industries are confronting changing supply and demand.

Apples are an important commodity in the United States and are commercially valued at over one billion dollars in revenue for growers (USDA/ERS). Primarily due to the development of dwarf varieties and improved cultural practices, apple production has increased from approximately 4,600 million pounds to 8,000 million pounds (Hallberg). During the past decade more productive dwarf varieties have reached maturity, and U.S. apple production has set a record high of 10,700 million pounds in 1987.

Apples are grown in three regions (western, eastern and central) throughout the United States covering thirty-five states. As shown in Table I.1, sixty-one percent of all U. S. fresh apples were supplied by the western region in 1990. The eastern states produced twenty-seven percent of U.S. apples, and the central states produced approximately twelve percent of the apples grown in the United States during the 1990 production season. Three states, Washington, New York and Michigan, are responsible for the majority of apple production in the United States. The state of Washington produced eighty-one percent of the western region's total apple production, and yields in New York accounted for thirty-nine percent of eastern production in 1990. Michigan produced sixty-six percent of the Central states apples.

Apples produced in the United States are sold for either fresh consumption or processing uses. As seen in Figure I.1, approximately one-half of all apples utilized go to fresh markets and the remainder go to processed markets (USDA/ERS). The allocation of apples between fresh and processing markets is broadly determined by crop size, apple quality and price. Apples sold on the fresh market must comply with U.S. grading standards and regulations. They can be classified as U.S. Extra Fancy, U.S. Fancy or U.S. No. 1 grade (Hallberg). The market for processed apple products includes: juice and cider, frozen, dried and other[1] apple products (Pearrow). During the last decade, juice apples made up the largest proportion of apples utilized in processing at approximately 2,000 million pounds (USDA/ERS).

During the last decade, apples were ranked second in the U.S. consumption of non-citrus fruits averaging 18.5 pounds per capita (Pearrow). The demand for fresh apples and processed apple products has fluctuated with changing consumer tastes and preferences. During the 20th century, per capita fresh apple consumption declined from a high of 62.5

[1] Other includes vinegar, jelly, apple butter, mincemeat and fresh slices.

Table I.1
APPLES, COMMERCIAL CROP: TOTAL PRODUCTION (MILLION LBS)

State	1988	1989	1990
Eastern States:			
Connecticut	38.0	24.0	33.0
Delaware	19.0	15.0	22.0
Georgia	33.0	25.0	22.0
Maine	94.0	69.0	88.0
Maryland	54.0	37.0	38.0
Massachusetts	88.0	78.0	85.0
New Hampshire	57.0	41.0	48.0
New Jersey	65.0	48.0	55.0
New York	910.0	960.0	990.0
North Carolina	350.0	220.0	230.0
Pennsylvania	520.0	320.0	520.0
Rhode Island	6.0	5.5	5.5
South Carolina	38.0	35.0	32.0
Vermont	45.0	45.0	41.0
Virginia	425.0	325.0	210.0
West Virginia	215.0	115.0	145.0
Total	**2957.0**	**2362.5**	**2562.0**
Central States:			
Arkansas	10.0	9.0	12.0
Illinois	85.0	91.0	60.0
Indiana	56.0	64.0	57.0
Iowa	9.5	11.5	9.6
Kansas	12.0	13.0	8.0
Kentucky	11.0	16.0	9.0
Michigan	830.0	950.0	750.0
Minnesota	14.0	31.0	20.0
Missouri	56.0	55.0	41.0
Ohio	95.0	125.0	120.0
Tennessee	12.5	11.5	8.5
Wisconsin	45.0	65.0	48.0
Total	**1236.0**	**1442.0**	**1143.1**
Western States:			
Arizona	0.0	34.0	64.0
California	630.0	675.0	650.0
Colorado	65.0	70.0	35.0
Idaho	135.0	158.0	165.0
New Mexico	10.0	5.3	6.8
Oregon	155.0	160.0	175.0
Utah	40.0	56.0	24.0
Washington	3900.0	5000.0	4700.0
Total	**4935.0**	**6158.3**	**5819.8**

Source: USDA/ERS, *Fruit and Tree Nuts Situation and Outlook Report,* Selected Issues.

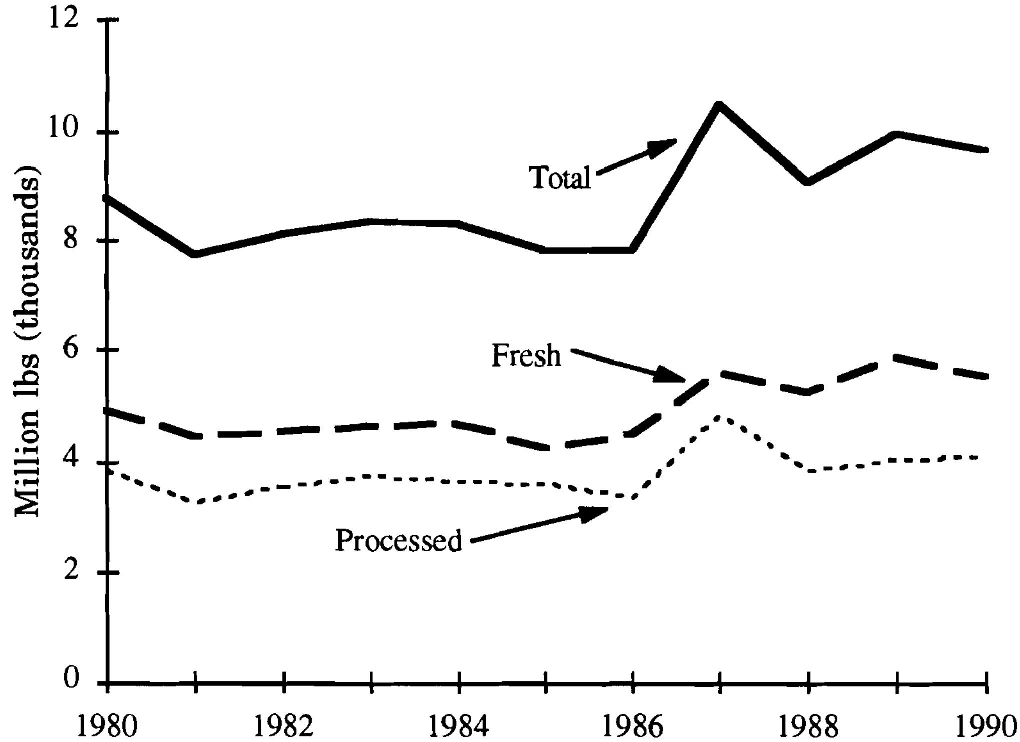

Figure I.1 APPLE UTILIZATION 1980-1990.
Source: USDA, Economic Research Service.
Fruit and Tree Nuts Situation and Outlook Report, Selected Issues.

pounds in 1920 to approximately 18.5 pounds[2] (Hallberg). In the most recent ten year period, however, apples have exhibited variation in per capita consumption. Comparing the first half of the decade to the last half of the decade, as seen in Figure I.2, fresh apple consumption has increased from an average of 18.1 pounds per capita to 20 pounds per capita(USDA/ERS). The emphasis on healthy eating has encouraged consumers to purchase more fresh apples. Consequently, the demand for traditional processed apple products like applesauce has either stagnated or declined. At the same time, growth in the apple juice market has increased to nearly twenty-five percent of the apples used in the processed market. The growth in the apple juice market can be related to changing consumer preference trends and an aggressive marketing strategy (Allison and Ricks).

[2]With increasing population, however, total U.S. apple consumption has not declined (Hallberg et al.).

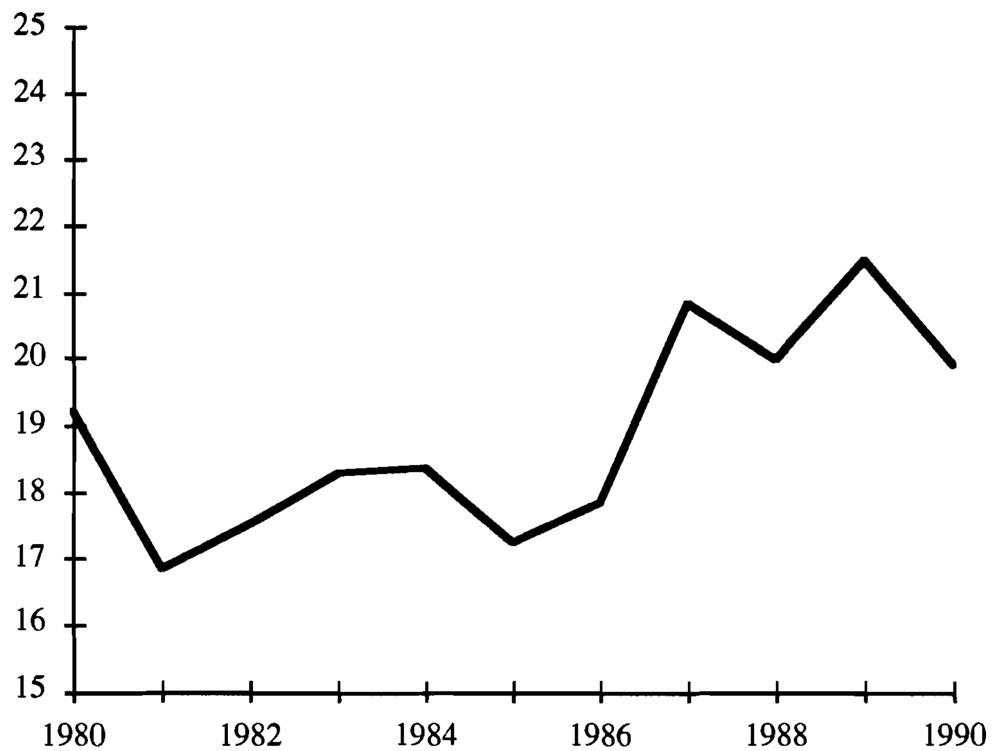

Figure I.2 PER CAPITA FRESH APPLE CONSUMPTION 1980-1990.
Source: USDA, Economic Research Service.
Fruit and Tree Nuts Situation and Outlook Report, Selected Issues.

A. The Apple Marketing and Distribution System

The majority of the nation's apples are harvested from the end of June until the beginning of November with the majority of the harvest during the month of August.[3] The volume of apples produced in a given year is dependent on the number of bearing trees and the yearly growing conditions. In the apple marketing system apple producers and consumers communicate to establish prices for apple products. Seasonality, marketing quality and apple variety influence the variation of apple prices.

Apples are priced on a daily basis, and different price offers are made for specific varieties, sizes, and grades of apples. Homogeneity within these categories limits large price changes on a daily and weekly basis. At the beginning of the month, price offers are adjusted based on apple stocks held over from the previous month. This process produces seasonal variation in the price of apples. For example, apple prices generally decline following harvest in August or September when apple stocks are at their highest, and

[3]The majority of New York apples are harvested in late September and early October.

continue to drop until they reach their lowest price in October. In February and March, when fresh apples are scarce, stocks are pulled from storage and prices begin to rise. The highest apple price is reached just before harvest (McGary). Thus, grower prices of apples fluctuate from year to year, from month to month, and from week to week (Tomek).

The apple marketing system begins with the grower and ends with the retailer. The traditional system also includes two intermediary components: the shipping point and the wholesale distributor. Shippers are the firms responsible for packing, storing and preparing the fruit for market. Wholesalers procure apples from shippers and move it to terminal markets where it is purchased by retailers. The retail value of apples is comprised of the transfer of prices between grower prices and three price spreads: 1) the grower-shipping point price spread 2) the shipping point-wholesale price spread and 3) the wholesale-retail price spread. Simply, apples move through a marketing chain from growers to shippers to wholesalers to retail outlets. Based on the definition of price spreads, marketing service costs are reflected in the price differentials between each market.

The traditional significance of the wholesale level in marketing fresh apples has diminished in recent years, and statistics on the movement of apples through the wholesale market are scarce. In fact, arrival data do not indicate how many apples received in a market actually passed through the terminal facility (How 1991, p. 295-6). The change in structure and organization of wholesale markets in recent years indicates retail firms purchase the majority of fresh fruits from shipping point sources through an integrated wholesale-retail system. Retailers rely on the wholesale market for specialty items, prepared products or fill-in purchases (How, 1993). These changes in the wholesale market suggest that shipping point prices play a greater role in establishing fresh fruit prices at other market levels. In this analysis, the wholesale market was included to maintain consistency with previous literature and to develop an understanding of all components of the apple market.

B. Objectives of the Study

The climate in which apple growers operate has changed creating a need for understanding the price transmission processes at all market levels. The objective of this study is to develop an understanding of the price transmission processes in the apple industry for both fresh apples and processed apple juice. Specific emphasis is placed on:

1. Formulating an economic model to investigate grower to retail price relationships in the apple industry (i.e. price lags and asymmetry).

2. Comparing price transmission responses between product varieties and forms (i.e. apple juice and fresh apples).

Based on considerations of data availability, economic models were developed for both fresh and juice markets. Grower, shipping-point, wholesale, and retail market levels were included in the fresh market models. Grower and shipping point market levels were included in the juice market models. Data on New York Red Delicious and New York McIntosh apples were used in the analysis. In Section II, the traditional assumptions of the markup model and development of marketing margin theory are presented. The implications of choosing the markup model are then canvassed, and the generalized model is explained. In Section III, the estimation procedures are reviewed and a discussion of results follow. Finally, conclusions and extensions are presented in Section IV.

SECTION II. MODEL DEVELOPMENT

The study of price transmission processes is based on price spreads and the theory of joint demand. The theory of joint demand stipulates that market based interactions at the retail level determine both the demand for retail food products and the demand for farm commodities as factors of production. The study of price spread relationships has relied on five assumptions which underlie the theory of joint demand and connect the markets for retail food, farm output, and marketing services within the food distribution system. These assumptions are: 1) perfect competition, 2) static equilibrium, 3) fixed proportions of inputs as factors of production, 4) constant supply of marketing inputs, 5) and immediate response of price changes from one level of the marketing system to the next level (Tomek and Robinson). Within this framework, market based interactions at the retail level determine the demand for both retail food products and the demand for farm commodities. The costs of marketing inputs, however, are assumed to be determined by forces outside of retail demand.

In modeling price spreads, the costs of marketing inputs have been expressed in terms of pricing rules. For example, George and King hypothesized that the costs of marketing services within the food marketing system could be represented by an absolute markup and a percentage markup over retail price. Alternative pricing rules were later developed (Gardner, Heien, and Wohlgenant), and in this analysis, a markup price similar to that specified by Heien was chosen.

A. Justification of the Markup Model

Due to the absence of a market wide auctioneer to drive the market clearing price (zero inventory) and the operational difficulty of restocking a zero level inventory, Heien hypothesized that managers rely on price changes at lower levels of the food distribution system to change retail prices. Using the conceptual framework specified by Gardner, Heien formulated a dynamic model based on a markup pricing rule, such that

$$(II.1) \quad r = a_1 w + a_2 z.$$

Retail price (**r**) is related to percentage markups $\mathbf{a_1}$ and $\mathbf{a_2}$[4] over wholesale prices (**w**) and the prices of other inputs (**z**). Heien proved his approach is economically and mathematically consistent in both short run and long run scenarios. In the short run, he used a Leontief production function which operates under the assumption that the inputs of production are required in fixed amounts. Heien argued that in the short run firms operate with fixed technology and cannot adjust to changes in factor prices. In the long run, he conceded that substitution may occur and, therefore, he used a Constant Elasticity of Substitution (**CES**) production function. Empirical tests of the markup model led to stable solutions suggesting that the markup pricing rule proposed by Heien produced consistent results with constant returns to scale and fixed technology.

The foundation of the markup pricing model rests on the hypothesis that prices of agricultural products and other inputs at lower levels of the marketing system cause prices

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[4]a_1 and a_2 are exogenous variables determined by past prices.

at higher market levels.[5] Causality tests, formulated by Granger and Sims to determine the direction of price information flows, are not used in this analysis because they are ambiguous, unreliable and heavily influenced by lack of variability in the data (Heien). Furthermore, in Heien's study of causality, the direction of price flows for a high percentage of the products studied fell into an "independent" range, where the direction of price flows was undetermined. Apples was one of the products. Consequently, causality from lower to higher market levels is assumed in this analysis, and tests for the existence of price lags and asymmetric price transmission behavior are developed under this hypothesis.

As mentioned previously, use of the markup model to describe price transmission in the apple industry is also dependent on three assumptions. First, a Leontief production technology is assumed. Second, constant returns to scale are assumed. Third, competitive markets prevail. Each assumption is addressed below.

The use of Leontief production technology implies that agricultural and marketing service inputs are used in fixed proportions. The relatively small amount of marketing service inputs required to market fresh apples and the limited technology employed in processing apple juice restrict the opportunities of substitution between factors of production. Consequently, the modeling of fixed proportions of factors of production in the apple industry is justified.

Constant returns to scale implies constant marginal costs which further imply that the volume of apples moving through the marketing system is not a relevant variable in the price transmission process (Kinnucan and Forker). The data suggest that over the ten year period, 1980-1990, fresh apple prices have remained relatively constant despite variable production. Furthermore, constant returns to scale in food processing technology is assumed in other studies of fresh fruit and vegetable markets (Ward; Thompson and Lyon; Carmen, Karrenbrock and Pick; and Heien) and supported by the results of Wohlgenant's research.

The apple industry is divided into five regions throughout the United States. Thirty-five states are involved in commercial production (USDA/ERS). Within each state hundreds of firms are involved in the production of apples. Several buyers of the apples exist in most regions. Therefore, the competitive market assumption is justified.

One of the drawbacks of the markup model is that it can only measure changes in price flows when shifts occur in either retail demand or agricultural supply, but not both. During the past decade, the apple industry has experienced shifts in both retail demand and supply. A large apple crop in 1987 followed by the alar incident in 1989 caused shifts in both supply and retail demand (USDA/ERS). In their study of price transmission processes for several dairy products Kinnucan and Forker conceded that "the existence of large inventories is expected to neutralize the effect of demand shifts because stocks and not prices would be affected" (Kinnucan and Forker pg. 290). This reasoning can also apply to the apple industry. As semi-perishable commodities, apples are stored throughout the marketing season and supply and demand shocks can be mitigated accordingly.

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[5]This implies a causal flow from grower prices to shipping point prices, from shipping point prices to wholesale prices, and from wholesale prices to retail prices.

B. Generalized Equations of the Apple Marketing System

As described in Section I, the fresh apple marketing system is characterized by the grower price and three price spreads: 1) the grower-shipping point price spread, 2) the shipping point-wholesale price spread, and 3) the wholesale-retail price spread. The transfer of prices between these levels comprises the retail value of apples (Pearrow). From this framework, two sets of equations were developed to test for price lags and asymmetric price transmission behavior in the apple marketing and distribution system.

In the generalized equations for each market level, price is defined as a function of markups over the price of apples at a lower market level and the cost of marketing service inputs.[6]

More specifically, retail prices are viewed as a function of wholesale prices and an index of average retail earnings for non-agricultural workers in retail trade (**RET**). This relationship can be expressed as

$$(II.2) \quad RETAIL\ PRICE = f_1(WHOLESALE\ PRICE,\ RET,\ \mu_1).$$

The variable **RET** was chosen to represent the costs store managers incur in retailing apples.

Wholesale prices are specified as a function of shipping point prices and a transportation variable (**TRANS**). The relationship can be expressed as

$$(II.3) \quad WHOLESALE\ PRICE = f_2(SHIPPING\ POINT\ PRICE,\ TRANS,\ \mu_2).$$

TRANS represents the cost of moving apples between shipping points and wholesale levels.

Shipping point prices are specified as a function of the grower price and the interest rate (**IR**). The interest rate is a proxy variable representing the opportunity cost growers forego by placing their apples in storage as seen by

$$(II.4) \quad SHIPPING\ POINT\ PRICE = f_3(GROWER\ PRICE,\ IR,\ \mu_3).$$

The apple juice marketing system is also characterized by the grower price and three price spreads: 1) the grower to shipping point price spread, 2) the shipping point to wholesale price spread, and 3) the wholesale to retail price spread. In this analysis data limitation precluded analysis of market levels other than the grower to shipping point price spread. The shipping point price for apple juice is specified as a function of grower prices and the interest rate (**IR**), chosen to represent the opportunity costs of holding processing equipment. This relationship can be seen as

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[6] A wide variety of inputs go into marketing a product (Harp). To avoid problems of multicollinearity and the lack of data, one variable was chosen to represent marketing inputs. This variable is an index of marketing costs representing the largest cost component of marketing apples at each market level.

$$(II.5) \quad \textit{SHIPPING POINT JUICE PRICE} = f_4(\textit{GROWER PRICE}, \textit{IR}, \mu_4).$$

C. Theoretical Considerations in Examining Price Lags and Asymmetry

1. Development of a Polynomial Price Lag Structure

The lagged effects of price transmission between market levels are commonly thought to occur due to institutional and technological constraints. Neither economic theory nor empirical evidence from the apple industry provide sufficient information for choosing a lag structure and determining lag length. Based on the research of Ward, the polynomial lag structure is hypothesized to provide an appropriate representation of a lagged pricing structure in the apple marketing and distribution system.

A low order polynomial of degree two with a lag length of four was chosen. A polynomial of degree two was chosen to conserve degrees of freedom. A lag length of four was chosen to reflect the time for the apple marketing system to clear. Three sets of equations covering the grower-shipping point, shipping point-wholesale and wholesale-retail price spreads for the fresh market were generated from the general specification of polynomial lags and Heien's markup model. An equation for the grower- shipping point price spread was generated for the juice market.

2. Irreversible Functions and Price Asymmetry

The empirical study of price response asymmetry requires special consideration in estimating techniques and procedures. The hypothesis of asymmetric price response behavior is based on the premise that price increases and price decreases at lower market levels have different impacts on retail price. For example, a simple model which could be used to study price transmission response specifies retail price ($\mathbf{P_r}$) as a function of wholesale price ($\mathbf{P_w}$) as seen by:

$$(II.6) \quad P_r = f(P_w).$$

If it is believed that price response behavior is asymmetric, the $\mathbf{P_w}$ variable is irreversible. Irreversibility implies that increases and decreases in the independent variable affect the dependent variable differently. Hence, a model in this form cannot be estimated by least squares or related procedures.

Including an irreversible variable in a model without specifying it correctly, in terms of increases and decreases, influences least squares estimation in two ways. First, it is impossible to determine the partial influence that each independent variable has on the dependent variable. Second, the coefficients of all other independent variables may be distorted, and the distortion may be so significant that signs of the coefficients are changed (Wolffram).

Wolffram's mathematical representation of an irreversible function involves splitting the irreversible variable into an increasing variable and a decreasing variable. More specifically, first difference calculations are used to separate the independent variable into two segments. For example, the variable $\mathbf{P_w}'$, representing increases of the initial $\mathbf{P_w}$ variable, is created by adding the positive first differences to the initial data value.[7] A $\mathbf{P_w}''$ variable representing decreases in the initial $\mathbf{P_w}$ variable is derived in a similar fashion. Technically, this separation technique requires that the newly formed variables representing increases and decreases meet the following conditions:

1) The opposite effects found in the irreversible variable are completely divided so that the change in $\mathbf{P_w}$ is distinctly separated into increasing($\mathbf{P_w}'$) and decreasing ($\mathbf{P_w}''$) components.

2) The number of observation values remains constant.

3) The sequence of rates of change and the position of the respective positive and negative values remain in sequence and are not altered.

4) "The variance of the dependent variable explained by the two newly formed variables has to correspond to the actual variance which has been caused by the particular independent variable." (Wolffram p. 357)

Based on Wolffram's separation techniques, Houck created a more operationally functional estimation procedure. The model differs from that explained by Wolffram because it looks at the net relationship between period to period changes. The benefits of this approach are that it does not require changing signs of the coefficients for comparison, and it defines the intercept term as a trend variable. Houck also emphasized that the first observation has no independent explanatory power because the issue of interest is the differential effects or changes from the previous level and not the initial level.

The hypothesis from which Houck derives his model is that one unit increases in the independent variable, **X**, and one unit decreases in **X** have different impacts on **Y**, the dependent variable. Mathematically, the relationship is expressed as

$$(II.7)\quad \Delta Y_i = \beta_0 + \beta_1 \Delta X_i' + \beta_2 \Delta X_i''$$

where:

$$\Delta Y_i = Y_i - Y_{i-1},$$
$$\Delta X_i' = X_i - X_{i-1} \text{ if } X_i > X_{i-1};\ =0 \text{ otherwise},$$
$$\Delta X_i'' = X_i - X_{i-1} \text{ if } X_i < X_{i-1};\ =0 \text{ otherwise}.$$

The equation above is linked to the initial data value through the following expression:

$$(II.8)\quad Y_t = Y_0 + \sum_{i=1}^{t} \Delta Y_i .$$

[7]Wolffram chose the first data point as his reference variable because it aids in identifying the first variable. The initial value, however, need only be a number greater than or equal to zero.

Substituting equation **II.8** into equation **II.7**, Houck's version of an irreversible equation is specified as

$$(II.9)\quad Y^*_t = \beta_0 t + \beta_1 R^*_t + \beta_2 D^*_t$$

where:

$$D^*_t = \sum \Delta X''_i ,$$
$$R^*_t = \sum \Delta X'_i ,$$
$$t = \textit{trend, and}$$
$$Y^*_t = Y_t - Y_0 .$$

According to this equation the sign of $\mathbf{R^*}$, the period to period increases, should always be positive and the sign of $\mathbf{D^*}$, the period to period decreases should always be negative. The coefficients β_1 and β_2 should be positive (negative) when a positive (negative) net relationship exists between **X** and **Y**.

Specifying the general equations in this manner enables testing the null hypothesis that pricing structure in the apple industry is symmetrical

$$H_o\colon \beta_1 = \beta_2$$

against the alternative

$$H_a\colon \beta_1 \neq \beta_2$$

that the pricing structure in the apple industry is asymmetric. The t-statistic used for this test is

$$(II.10)\quad t = \frac{(\hat{\beta}1 - \hat{\beta}2) - (\beta 1 - \beta 2)}{\sqrt{\operatorname{var}(\hat{\beta}1) + \operatorname{var}(\hat{\beta}2) - 2\operatorname{cov}(\hat{\beta}1\hat{\beta}2)}}$$

where β_1 and β_2 are the estimated coefficients on the rising and falling prices respectively. The values for variance and covariance are calculated during the estimation procedure.

D. The Empirical Model Used to Estimate Price Lags

Based on the theoretical discussion of price lags, an empirical model was developed for the apple industry. To develop an understanding of how apple variety and product form may influence price transmission processes within a single industry, the model is specified for the fresh and processed market. Both New York Red Delicious and McIntosh apples are considered in the fresh market. The wholesale-retail point, shipping point-wholesale and grower-shipping point price spreads are examined for the fresh market. Only the grower-shipping point price spread is analyzed for apple juice.

1. Wholesale-Retail Price Spread

At the retail level two equations were formulated for fresh apples; one equation for New York Red Delicious apples and another equation for New York McIntosh apples.

The retail price of New York Red Delicious apples is defined as a function of the lagged wholesale prices of New York Red Delicious apples (**WPNRO, WPNR1, WPNR2**) and the cost of retailing apples (**RET**) as seen by

$$(II.11)\ RUS_t = \alpha_0 + \alpha_1\, WPNRO_t + \alpha_2\, WPNR1_t + \alpha_3\, WPNR2_t + \alpha_4\, RET_t + \varepsilon_{1t}$$

where **RUS** is the retail price of fresh apples in the United States. **WPNRO, WPNR1,** and **WPNR2** are variables derived from the polynomial lag specification explained in Table II.1 and in Appendix I. The variable **RET** is not lagged to conserve degrees of freedom. Furthermore, it is believed that store managers like to "smooth values" of marketing inputs to avoid changing prices (Heien).

Table II.1
WHOLESALE PRICE LAGS FOR NEW YORK RED DELICIOUS APPLES

WPNRO = WNYRD + WNYRD1 * DUM1[1] + WNYRD2 * DUM2
+ WNYRD3 * DUM3 + WNYRD4 * DUM4
WPNR1 = WNYRD1 * DUM1 + 2 * WNYRD2 * DUM2 + 3 * WNYRD3 * DUM3
+ 4 * WNYRD * DUM4
WPNR2 = WNYRD1 * DUM1 + 4 * WNYRD2 * DUM2 + 9 * WNYRD3 * DUM3
+ 16 * WNYRD4 * DUM4

where:
WNYRD1 = Wholesale Price of New York Red Delicious Apples Lagged 1 Period
WNYRD2 = Wholesale Price of New York Red Delicious Apples Lagged 2 Periods
WNYRD3 = Wholesale Price of New York Red Delicious Apples Lagged 3 Periods
WNYRD4 = Wholesale Price of New York Red Delicious Apples Lagged 4 Periods

[1]Dummy Variables (DUM1, DUM2, DUM3 and DUM4) allow for estimation of discontinuous time series and seasonal data. A complete discussion can be found in Section III, Estimation and Empirical Results, of this report.

According to the theory of marketing margins, and the theory of derived demand, the signs on all coefficients are expected to be positive. Rising prices at the wholesale level are expected to cause price increases at the retail level. Moreover, increasing costs of marketing service inputs are also expected to add to retail costs.

The equation defined for New York McIntosh apples is analogous to the equation described for New York Red Delicious apples except that the lagged wholesale prices for New York McIntosh apples (**WPNM0, WPNM1, WPNM2**) are used such that

$$(II.12)\ RUS_t = \beta_0 + \beta_1 WPNMO_t + \beta_2 WPNM1_t + \beta_3 WPNM2_t + \beta_4 RET_t + \varepsilon_{2t}.$$

The lagged wholesale price variables for New York McIntosh apples are derived analogously to those in Table II.1 and are explained further in Appendix I. The signs of all the coefficients are expected to be positive.

2. Shipping Point-Wholesale Price Spread

Wholesalers pay shipping point prices and receive wholesale prices for the product. Empirical evidence suggests that transportation costs are the largest marketing cost component at this level of the marketing system (Pearrow). Therefore, a variable of transportation rates was included in the model.

The equations derived to represent the shipping point-wholesale price spread are:

$$(II.13)\ WNYRDC_t = \gamma_0 + \gamma_1 FPRD0_t + \gamma_2 FPRD1_t + \gamma_3 FPRD2_t + \gamma_4 NYAT_t + \varepsilon_{3t},$$

$$(II.14)\ WNYRDC_t = \delta_0 + \delta_1 FPRD0_t + \delta_2 FPRD1_t + \delta_3 FPRD2_t + \delta_4 NYNYC_t + \varepsilon_{4t},$$

$$(II.15)\ WNYMCC_t = \phi_0 + \phi_1 FPMC0_t + \phi_2 FPMC1_t + \phi_3 FPMC2_t + \phi_4 NYAT_t + \varepsilon_{5t},\ and$$

$$(II.16)\ WNYMCC_t = \lambda_0 + \lambda_1 FPMC0_t + \lambda_2 FPMC1_t + \lambda_3 FPMC2_t + \lambda_4 NYNYC_t + \varepsilon_{6t}.$$

Equations **II.13** through **II.16** suggest that the wholesale price of New York Red Delicious apples (**WNYRDC**) and McIntosh apples (**WNYMCC**) are a function of the polynomial lag price structure of shipping point prices (**FPRD0**, **FPRD1**, **FPRD2**, **FPMC0**, **FPMC1** and **FPMC2**) and transportation costs from New York to New York City and from New York to Atlanta (**NYNYC**, **NYAT**[8]). The polynomial lag structures for the shipping point prices are more fully described in Appendix I.

NYAT and **NYNYC** represent the truck rate of each container of tray packed apples from central New York to Atlanta and from central New York to New York City respectively. It is assumed that current supply and demand forces are primarily responsible for apple movements and that current transportation costs do not limit apple movement. Consequently, the transportation variables are not lagged. Under the assumption that shipping point prices cause wholesale prices, the coefficients on the lagged price variables are expected to be positive. Similarly, increased transportation costs should lead to increased wholesale prices.

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[8] Transportation costs were used for two cities, New York and Atlanta, to test for consistency of the results.

3. Grower-Shipping Point Price Spread

At the grower-shipping point level of the apple marketing and distribution system, two equations were developed to explain the shipping point price: one for New York Red Delicious apples (**FHVRDC**) and another for New York McIntosh apples (**FNYMCC**).

The equation for Red Delicious apples is

$$(II.17)\quad FHVRDC_t = \eta_0 + \eta_1\, FPP0_t + \eta_2\, FPP1_t + \eta_3\, FPP2_t + \eta_4\, IR_t + \varepsilon_{7t}.$$

The equation for New York McIntosh apples is specified similarly as seen by

$$(II.18)\quad FNYMCC_t = \varphi_0 + \varphi_1\, FPP0_t + \varphi_2\, FPP1_t + \varphi_3\, FPP2_t + \varphi_4\, IR_t + \varepsilon_{8t}.$$

The shipping point prices of New York Red Delicious apples (**FHVRDC**) and New York McIntosh apples (**FNYMCC**) are caused by lagged grower prices for fresh apples (**FPP0, FPP1, FPP2**) and the opportunity cost of storage (**IR**). See Appendix 1 for development of the polynomial lag structures.

The opportunity costs of storage are represented by the current interest rate (**IR**) because shipping point distributors forego interest on the value of apple stocks in storage.

As explained for the previous market levels, the expected signs on the lagged price variables are positive. Increases in grower prices should lead to increases in shipping point prices. The expected sign on the variable representing storage costs (**IR**) should also be positive as increases in the costs of storage are hypothesized to be reflected in increased shipping point prices.

4. Grower-Shipping Point Price Spread for Apple Juice

The shipping point price of apple juice is a function of the polynomial lagged grower prices for processing apples[9] (**FPPO, FPP1, FPP2**) and the interest rate (**IR**). In this form, **IR** was chosen to represent the opportunity costs of holding processing equipment as seen by

$$(II.19)\quad JUICE_t = \tau_0 + \tau_1\, FPP0_t + \tau_2\, FPP1_t + \tau_3\, FPP2_t + \tau_4\, IR_t + \varepsilon_{9t}.$$

The coefficients on the lagged grower price variables are expected to be positive. Similarly, increases in the interest rate should lead to increased shipping point prices.

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[9] Monthly data for the price of processing apples was unavailable. Based on a comparison of fresh and processing price data collected on a yearly basis, and the nature of the apple market, grower prices for fresh apples were deemed a suitable proxy for the price of processing apples.

E. A Description of Price Symmetry

Based on the research of Wolffram and Houck described earlier in the chapter, the generalized price transmission equations were specified as irreversible functions to test the hypothesis of price symmetry. Because the markup model is hypothesized to represent the underlying pricing structure in the apple industry, the price variables and variables representing marketing costs remain the same as those described previously. The price of apples at higher market levels are a function of price increases and decreases at lower market levels. The coefficients of variables representing price increases and price decreases should be positive as they have a net positive impact on higher market level prices.

Nine equations were derived for this study. Two equations, **II.20** and **II.21** describe the wholesale-retail price spread for fresh New York Red Delicious apples and fresh New York McIntosh apples. The shipping point-wholesale price spread is captured by equations **II.22** through **II.25**. Four equations are used to reflect two apple varieties, New York Red Delicious and New York McIntosh, and two transportation rates, New York to New York City and New York to Atlanta. The grower-shipping point price spread for fresh New York Red Delicious apples and fresh New York McIntosh apples are measured by equations **II.26** and **II.27**. The grower-shipping point price spread for apple juice is captured by equation **II.28**. These equations are:

1. **Wholesale-Retail Price Spread**

(II.20) $RUS_t = \psi_1 + \psi_2 RUWNYRD_t + \psi_3 FDWNYRD_t + \psi_4 RET_t + \varepsilon_{10t},$

(II.21) $RUS_t = \psi_{11} + \psi_{12} RUWNYMC_t + \psi_{13} FDWNYMC_t + \psi_{14} RET_t + \varepsilon_{11t},$

2. **Shipping Point-Wholesale Price Spread**

(II.22) $WNYRD_t = \psi_{21} + \psi_{22} RUFHVRD_t + \psi_{23} FDFHVRD_t + \psi_{24} NYAT_t + \varepsilon_{12t},$

(II.23) $WNYRD_t = \psi_{31} + \psi_{32} RUFHVRD_t + \psi_{33} FDFHVRD_t + \psi_{34} NYNYC_t + \varepsilon_{13t},$

(II.24) $WNYMC_t = \psi_{41} + \psi_{42} RUFNYMC_t + \psi_{43} FDFNYMC_t + \psi_{44} NYAT_t + \varepsilon_{14t},$

(II.25) $WNYMC_t = \psi_{51} + \psi_{52} RUFNYMC_t + \psi_{53} FDFNYMC_t + \psi_{54} NYNYC_t + \varepsilon_{15t},$

3. **Grower-Shipping Point Price Spread**

(II.26) $FHVRDC_t = \psi_{61} + \psi_{62} RUUFP_t + \psi_{63} FDDDFP_t + \psi_{64} IR_t + \varepsilon_{16t},$

(II.27) $FNYMCC_t = \psi_{71} + \psi_{72} RUUFP_t + \psi_{73} FDDDFP_t + \psi_{74} IR_t + \varepsilon_{17t},$ *and*

4. **Grower-Shipping Point Price Spread for Apple Juice**

$$(II.28)\quad JUICE_t = \psi_{81} + \psi_{82} RUUFP_t + \psi_{83} FDDDFP_t + \psi_{84} IR_t + \varepsilon_{18t}.$$

The difference in the equations stems from the separation of the "leading" price variables into price increases (represented by the prefix **RU**) and price decreases (represented by the prefix **FD**). A detailed explanation of the variables used can be found in Table II.2.

Table II.2
PRICES USED IN TESTING FOR PRICE ASYMMETRY

	WHOLESALE-RETAIL PRICE SPREAD
RUS	Retail price of fresh Red Delicious apples
RUWNYRD	Increasing wholesale price of New York Red Delicious apples
FDWNYRD	Decreasing wholesale price of New York Red Delicious apples
RUWNYMC	Increasing wholesale price of New York McIntosh apples
FDWNYMC	Decreasing wholesale price of New York McIntosh apples
	SHIPPING POINT-WHOLESALE PRICE SPREAD
WNYRD	Wholesale price of New York Red Delicious apples
WNYMC	Wholesale price of New York McIntosh apples
RUFHVRD	Increasing shipping point price of New York Red Delicious apples
FDFHVRD	Decreasing shipping point price of New York Red Delicious apples
RUFNYMC	Increasing shipping point price of New York McIntosh apples
FDFNYMC	Decreasing shipping point price of New York McIntosh apples
	GROWER-SHIPPING POINT PRICE SPREAD
FHVRDC	Shipping point price of New York Red Delicious apples
FNYMCC	Shipping point price of New York McIntosh apples
JUICE	Shipping point price of apple juice
RUUFP	Increasing price received by growers for fresh apples
FDDDFP	Decreasing price received by growers for fresh apples

SECTION III. ESTIMATION PROCEDURES AND EMPIRICAL RESULTS

In this section, the estimation procedures and empirical results of price transmission processes for the three market levels of the apple industry are reported. The results of estimation for both lag structures and price symmetry are analyzed. The results of the polynomial lag estimation are discussed, and changes to the original lag structure are presented.

A. Data Sources

Monthly prices from 1980 through 1990 are analyzed for New York Red Delicious and New York McIntosh apples. Prices at the wholesale and shipping point levels represent the price of apples in forty-two pound carton tray packs. Retail and grower prices[10] represent the prices, in cents per pound, received on all fresh apples in the United States. The price series are not deflated because the purpose of this analysis was to examine the behavior of nominal prices and not relative prices. Furthermore, different deflators are required for each market level making comparisons between levels difficult.

Fresh apple prices were published by the Agricultural Marketing Service, the USDA, and the Bureau of Labor Statistics. Shipping point prices for apple juice in twelve thirty-two ounce containers were found in the *Food Institute Report*. Data for variables representing marketing inputs (**RET, IR, STOR**) are from *The Survey of Current Business* and *Cold Storage Report*. All raw data used in this research can be found in Appendix 2.

B. Estimation Procedures

Apples are a semi-perishable commodity harvested each fall, and stocks are not carried over from year to year. In some cases, like New York Red Delicious and New York McIntosh apples, supplies of fresh apples are not sufficient to last from season to season. Consequently, apple price series are both discontinuous and seasonal. An econometric technique, developed by Ward, was used to handle data with gaps and seasonal price flows. A matrix of dummy variables, where the columns of the matrix represent the current and lagged periods, was specified to ensure that only relevant prices are taken into account during the estimation process.[11]

Joint determination of apple allocation between the fresh and processing markets allows for correlation between the error terms. Therefore, Seemingly Unrelated Regression (**SUR**) techniques were initially considered for estimation in this analysis. Furthermore, the use of Seemingly Unrelated Regression (**SUR**) implies that the error terms are

[10]Beginning in 1985, New york apple grower prices are based on packinghouse door equivalent rather than as sold price. Washington state apples have always been reported as packing house door equivalent. Because of data availability, grower price data used in this analysis are national statistics which have no change in definition reported in 1985.

[11]Dummy variables (DUM1, DUM2, DUM3 and DUM4) are created for discontinuous and seasonal data described by Ward. They are used in the development of the polynomial lagged structure described in Section II.

contemporaneously correlated. This is a reasonable assumption because random events, such as weather, affect all levels of the marketing system and are captured by the error term. However, the market levels used in this analysis are not directly comparable and data for the apple juice market were only available at the grower-shipping point level. Consequently, the model was estimated using Ordinary Least Squares (**OLS**). Consistently low Durbin-Watson statistics required the use of the autoregression correction procedure (**FGLS**). **SAS** was used for all estimation.

C. Results of the Polynomial Price Lag Structure

The three sets of equations using a polynomial lag structure and covering the wholesale-retail, shipping point-wholesale, and grower-shipping point price spreads were estimated. Across all equations, the Durbin-Watson statistic revealed the presence of autocorrelation. Consequently, the models were re-estimated using the autoregression correction procedure (**FGLS**). Counter-intuitive signs on lagged price variables at all levels of the market and the lack of theoretical support for retaining the polynomial lag structure, led to the rejection of the polynomial lag structure of apple price transmission.

D. Distributed Lags

In order to more fully explore the role of lagged prices in the apple industry, the lagged price spread equations were re-specified using a distributed lag formulation.

The distributed lag structure was estimated for the three levels of the apple marketing and distribution system. The original estimation of the second degree polynomial lag structure required the use of four lags. Consequently, each distributed lag equation was originally re-estimated with four lagged periods. The results indicated that lags of four months are not important for fresh apples and apple juice. The results found in Tables III.1-III.4 suggest that distributed lag models specified as either a combination of current price and price lagged one period or as only one of these prices had the greatest significance.

R-square values for the equations estimated using **FGLS** ranged from 0.749 to 0.902. Strong positive t-ratios were found on both the current price and price variables lagged one period across all market levels. Relatively high Pearson correlation coefficients between price variables indicate high inter-correlations between variables. Explaining the significance of the current price in the price transmission process is difficult. Even if the wholesale market is fully integrated and operationally efficient, as argued by Ward, it seems improbable that price information from one market level can be transmitted instantaneously to the next market level. Hence, the results from this estimation process suggest that monthly data were insufficient to determine appropriate lag pricing structures for the apple industry. In other words, the lag prices operating in the apple industry may lie somewhere between the current price and the monthly price.

1. Wholesale-Retail Price Spread

In the retail markets for both New York Red Delicious and New York McIntosh apples, it was difficult to distinguish between the effects of current wholesale price and wholesale price lagged one period in explaining retail prices. The presence of multicollinearity between the current price variable and the price variable lagged one period obscured the results and a specific price lag structure could not be identified.

Results of New York Red Delicious apples reported in Table III.1, indicate that current wholesale price (**WNYRDC**) and wholesale price lagged one period (**WNYRD1**) are statistically significant. The cost of retailing (**RET**) is significant and positive. This suggests that marketing costs at the retail level affect retail price.

The results for New York McIntosh apples also found in Table III.1. suggest that the presence of multicollinearity between the variables leads to inefficient estimation. In equation 4a, the wholesale price of McIntosh apples lagged one period (**WNYMC1**) is statistically significant at five percent. However, when the current price of McIntosh apples is removed, in equation 5a, **WNYMC1** becomes insignificant. Again, the cost of retailing apples (**RET**) is significant and positive, although of a somewhat lower magnitude than for Red Delicious apples. This suggests that the cost of retailing apples may affect the retail price of New York McIntosh apples differently than the retail price of Red Delicious apples.

The Pearson correlation coefficients reveal a high degree of multicollinearity among the price variables. The current wholesale price of New York Red Delicious apples (**WNYRDC**) is strongly correlated to wholesale price lagged one period (**WNYRD1**), with a Pearson coefficient of 0.833.

2. Shipping Point-Wholesale Price Spread

At this market level, transportation fees were identified as an important part of the shipping point-wholesale price spread (Pearrow). Consistently, the transportation variable was insignificant at the 5% level. In order to improve the model, a storage variable (**STOR**) measuring the amount of apples in cold storage facilities each month was chosen to represent marketing service costs. When storage levels are high the amount of apples in the marketing system is relatively high. Consequently, relatively low levels of trading will take place between the shipping point and wholesale levels and total transportation costs are low.

As seen in Table III.2, at the wholesale market level for New York Red Delicious apples, current shipping point price (**FHVRDC**) is significant at the 5% level when it is specified with the lagged price (**FHVRD1**) and when it is specified by itself. The shipping point price lagged one period (**FHVRD1**) is significant at the 5% level only in equation 8a without the current price. In all equations, the t-ratios on **STOR** are significant and the coefficients are negative. This is consistent with economic theory indicating that increases in storage would be related to a decrease in apple movements and in turn cause a decrease in wholesale prices.

At the wholesale level for McIntosh apples, the results are quite different than for the market of New York Red Delicious apples. At this level the equation used for estimation was not autocorrelated and only the **OLS** results are reported in Table III.2. The **OLS** results indicate that neither the current (**FNYMCC**) shipping point price nor the shipping point price lagged one period (**FNYMC1**) are significant when estimated in equation 10. When **FNYMCC** or **FNYMC1** are removed and estimated separately in equations 11 and 12, each becomes statistically significant at the 5% level, again reflecting the consequences of multicollinearity.

Table III.1
RESULTS OF THE DISTRIBUTED LAG MODEL FOR THE WHOLESALE-RETAIL PRICE SPREAD

NEW YORK RED DELICIOUS
DEPENDENT VARIABLE: RUS

	OLS			FGLS		
EQU #	1	2	3	1a	2a	3a
INT	-0.572	-0.494	-0.509	-0.326	0.894	-0.340
	(-6.857)	(-5.107)	(-5.515)	(-2.201)	(0.411)	(-2.438)
WNYRDC	1.351		1.404	0.792		1.127
	(6.281)		(10.863)	(4.659)*		(6.914)*
WNYRD1	0.138	1.286		0.402	0.424	
	(0.649)	(9.797)		(2.634)*	(2.662)*	
RET	0.00490	0.00474	0.00466	0.00391	0.00263	0.00416
	(11.606)	(9.626)	(9.960)	(5.116)*	(2.215)*	(5.627)*
R2	0.776	0.659	0.688	0.883	0.857	0.800
DW	1.116	1.021	1.058			
RHO				-0.730	-0.889	-0.580
				(-9.064)	(-17.783)	(-6.533)
OBS	77	87	88	76	86	87

NEW YORK MCINTOSH
DEPENDENT VARIABLE: RUS

	OLS			FGLS		
EQU #	4	5	6	4a	5a	6a
INT	0.0745	0.0635	-0.0102	0.106	-0.0839	0.0315
	(0.696)	(0.572)	(-0.093)	(0.518)	(-0.383)	(0.165)
WNYMCC	-0.0362		0.352	-0.0308		0.0547
	(-0.183)		(2.229)	(-0.325)		(0.434)
WNYMC1	0.607	0.502		0.218	0.155	
	(2.948)	(3.210)		(2.213)*	(1.557)	
RET	0.00219	0.00242	0.00310	0.00275	0.00392	0.00347
	(2.934)	(3.226)	(4.486)	(2.318)*	(3.192)*	(3.080)*
R2	0.407	0.351	0.352	0.856	0.831	0.759
DW	0.648	0.628	0.623			
RHO				-0.874	-0.874	-0.754
				(-15.789)	(-16.945)	(-10.875)
OBS	82	93	94	81	92	93

*Indicates significance at 5%

Table III.2
RESULTS OF THE DISTRIBUTED LAG MODEL FOR THE SHIPPING POINT-WHOLESALE PRICE SPREAD

NEW YORK RED DELICIOUS
DEPENDENT VARIABLE: WNYRDC

	OLS			FGLS		
EQU #	7	8	9	7a	8a	9a
INT	4.371 (3.556)	4.926 (3.682)	4.668 (4.060)	5.662 (3.284)*	7.073 (4.352)*	5.994 (4.164)*
FHVRDC	0.766 (6.608)		0.691 (10.863)	0.517 (2.786)*		0.593 (3.877)*
FHVRD1	-0.0428 (-0.252)	0.667 (5.224)		0.0656 (0.378)	0.428 (2.751)*	
STOR	-0.00057 (-3.756)	-0.00060 (-3.816)	-0.00054 (-4.379)	-0.00053 (-2.948)*	-0.00042 (-2.931)*	-0.00041 (-2.863)*
R2	0.614	0.455	0.549	0.726	0.694	0.727
DW	1.117	0.848	0.940			
RHO				-0.545 (-4.415)	-0.631 (-6.039)	-0.617 (-5.811)
OBS	51	59	59	50	58	58

NEW YORK MCINTOSH
DEPENDENT VARIABLE: WNYMCC

	OLS			FGLS
EQU #	10	11	12	
INT	2.584* (1.966)	2.914* (2.298)	2.734* (2.147)	
FNYMCC	0.369 (0.952)		0.0938 (9.374)	
FNYMC1	0.524 (1.344)	0.866 (8.959)		
STOR	0.00098 (0.635)	0.00014 (0.980)	0.000073 (0.507)	
R2	0.609	0.565	0.599	
DW	1.829	1.928	1.765	
RHO				
OBS	57	65	63	

*Indicates significance at 5%

In all equations, the t-ratios on **STOR** are insignificant and positive. This is inconsistent with economic theory and with the results of previous equations. One explanation might be that apple varieties exhibit different marketing patterns. This may be important in New York where McIntosh apples are produced in greater quantities than Red Delicious apples.

3. Grower-Shipping Point Price Spread

The results of the grower-shipping point price spread, presented in Table III.3, are similar to those presented for the shipping point-wholesale price spread. For Red Delicious apples, the t-ratio on the coefficient of the grower price lagged one period (**FPPP1**) increased from 1.639 to 3.634 when the current grower price was dropped from equation 13a. The changing t-ratio is indicative of the problems associated with correlation among the price variables. The t-ratio for the current grower price (**FP**) maintained consistency at the 5% level in both equations 13a and 15a. The coefficients of **IR** are insignificant in all equations, and the correct sign in only one equation. It appears that the interest rate does not capture the true operating costs of storage nor does it isolate its effect. One explanation for the reduced significance of the **IR** variable is that apple growers do not consider the opportunity costs of storage because the apple marketing system is designed to provide apples throughout the year.

The results for McIntosh apples reveal that lagged and current grower prices do not influence shipping point prices. The marketing cost variable is also insignificant.

4. Grower-Shipping Point Price Spread for Apple Juice

The results in Table III.4 for the grower-shipping point price spread of apple juice were unanticipated. A priori the coefficients on the grower price of apples were expected to be positive; an increase in the grower price of apples should lead to an increase in the price of apple juice.

Contrary to expectations, the signs on the grower price coefficients were negative. Two explanations for the phenomenon exist. First, the price of apples used in processing juice is relatively minor compared with the price of processing, packaging and marketing services involved in apple juice production. Therefore, the cost of marketing services could drive the pricing process for apple juice. Changing apple prices would then have less of an impact on shipping point prices than increased efficiency in these areas, thereby causing negative coefficients. Second, imports of apple juice concentrate have been increasing over the last decade. More apple juice on the market from sources outside the United States could cause a drop in apple juice prices which overshadows the forces driving apple markets in the United States. Negative price coefficients could result.

T-ratios on the current grower price (**FP**) are insignificant in both equations 19a and 21a. Furthermore, the grower price lagged one period (**FPPP1**) is significant in equation 20a. These results suggest that lag pricing structures of up to one month are important in the apple juice industry. **IR** is significant in all equations. This suggests that the opportunity costs of processing technology are important factors in shipping point prices of apple juice.

Table III.3
RESULTS OF THE DISTRIBUTED LAG MODEL FOR THE GROWER-SHIPPING POINT PRICE SPREAD

NEW YORK RED DELICIOUS
DEPENDENT VARIABLE: FHVRDC

	OLS			FGLS		
EQU #	13	14	15	13a	14a	15a
INT	0.0844 (3.767)	0.101 (4.440)	0.0919 (4.172)	0.111 (3.407)*	0.162 (4.654)*	0.132 (4.421)*
FP	0.607 (2.940)		0.871 (8.113)	0.573 (3.888)*		0.695 (5.404)*
FPPP1	0.309 (1.491)	0.831 (7.371)		0.235 (1.639)	0.499 (3.624)*	
IR	0.00115 (1.319)	0.00609 (0.679)	0.00115 (1.313)	0.00023 (0.142)	-0.00042 (-0.212)	-0.00010 (-0.062)
R2	0.532	0.469	0.516	0.813	0.771	0.806
DW	0.644	0.710	0.665			
RHO				-0.798 (-10.583)	-0.821 (-12.082)	-0.896 (-10.592)
OBS	69	69	69	68	68	68

NEW YORK MCINTOSH
DEPENDENT VARIABLE: FNYMCC

	OLS			FGLS		
EQU #	16	17	18	16a	17a	18a
INT	0.226 (5.788)	0.321 (12.592)	0.239 (6.371)	0.0263 (5.960)*	0.277 (7.486)*	0.282 (6.464)*
FP	0.553 (3.086)		0.592 (3.358)	0.0856 (0.623)		0.00216 (0.017)
FPPP1	0.130 (1.166)	0.196 (1.686)		0.0618 (1.422)	0.0511 (1.293)	
IR	-0.00345 (-2.196)	-0.00537 (-3.522)	-0.00347 (-2.205)	-0.00031 (-0.012)	-0.000022 (-0.008)	0.00016 (0.05962)
R2	0.280	0.185	0.266	0.880	0.880	0.878
DW	0.561	0.590	0.616			
RHO				-0.926 (-20.722)	-0.931 (-21.707)	-0.939 (-23.101)
OBS	76	76	76	75	75	75

*Indicates significance at 5%

Table III.4
RESULTS OF THE DISTRIBUTED LAG MODEL FOR THE GROWER-SHIPPING POINT PRICE SPREAD

JUICE
DEPENDENT VARIABLE: JUICE

	OLS			FGLS		
EQU #	19	20	21	19a	20a	21a
INT	5.522 (31.906)	5.461 (39.352)	5.484 (32.213)	5.580 (21.349)*	5.537 (23.835)*	5.498 (21.176)*
FP	-0.397 (-0.595)		-0.683 (-1.103)	-0.252 (-0.365)		-0.343 (-0.489)
FPPP1	-0.564 (-1.141)	-0.722 (-1.580)		-0.619 (-0.378)	-0.632 (-2.310)*	
IR	0.121 (10.893)	0.122 (11.296)	0.121 (10.883)	0.115 (5.545)*	0.115 (5.490)*	0.115 (5.600)*
R2	0.621	0.617	0.615	0.799	0.801	0.786
DW	0.838	0.820	0.870			
RHO				-0.665 (-8.014)	-0.677 (-8.380)	-0.652 (-7.796)
OBS	86	87	86	85	86	85

*Indicates significance at 5%

E. Price Asymmetry Estimation

The hypothesis of asymmetric price response behavior is based on the premise that price increases and price decreases at lower market levels impact prices at higher market levels differently. As explained in Section II, Houck developed a method of estimating irreversible functions which can be applied to tests of price asymmetry in the apple marketing and distribution system.

Consistently low Durbin-Watson statistics for the **OLS** estimation again required the use of the autoregression correction procedure (**FGLS**) available in **SAS**.

1. Wholesale-Retail Price Spread

The null hypothesis for pricing symmetry is rejected for the wholesale-retail price spread of fresh New York Red Delicious apples as seen in Table III.5. The calculated t-statistic of 4.838 exceeds the t-criterion of 1.994 at the 5% level with 67 degrees of freedom. The t-ratio, reported in Table III.5, on the increasing wholesale prices of New York Red Delicious apples (**RUWNYRD**) is highly significant with a value of 6.070. The t-ratio on falling wholesale prices (**FDWNYRD**), 1.119, is insignificant. These results indicate that only increasing wholesale prices influence retail prices. In the marketing of New York Red Delicious apples, **RET** was both the correct sign and significant.

The null hypothesis for pricing symmetry is also rejected for the wholesale-retail price spread of New York McIntosh apples as seen in Table III.5. The calculated t-statistic of 4.304 exceeds the t-criterion of 1.665 at the 5% level with 77 degrees of freedom. However, the results for New York McIntosh apples differ significantly from the results for Red Delicious apples. The t-ratio on the increasing wholesale prices of McIntosh apples (**RUWNYMC**) is insignificant with a value of 0.967. The coefficient on decreasing prices of McIntosh apples (**FDWNYMC**) are of the wrong sign and significant.

The difference in the results of Red Delicious and McIntosh apples may be explained by the use of a highly aggregated retail price variable. The retail price variable **RUS** represents an U.S. city average price for all fresh apples. Washington Red Delicious apples account for nearly 50% of all fresh apples marketed in the United States. Therefore, by nature of the apple industry, the retail price reported by the Bureau of Labor Statistics is heavily influenced by the price received for Washington Red Delicious apples. Based on graphical comparison between prices for Red Delicious and McIntosh apples, it was assumed that all apple prices move together. Consequently, **RUS** was also chosen to represent the retail price of McIntosh apples. These results suggest that this assumption may be incorrect, and that a highly aggregated variable like **RUS** may not represent fully the retail price of McIntosh apples.

Table III.5
RESULTS OF THE PRICE SYMMETRY EQUATION FOR THE WHOLESALE-RETAIL PRICE SPREAD

NEW YORK RED DELICIOUS
DEPENDENT VARIABLE: RUS

	OLS	FGLS
TRD	-0.155 (-1.468)	0.121 (0.589)
RUWNYRD	1.452 (6.166)	1.166 (6.070)*
FDWNYRD	0.0588 (0.409)	0.216 (1.119)
RET	0.00436 (7.020)	0.00291 (2.483)*
R2	0.629	0.884
DW	0.636	
RHO		-0.866 (-14.158)
OBS	72	71

NEW YORK MCINTOSH
DEPENDENT VARIABLE: RUS

	OLS	FGLS
TRD	-0.0328 (-0.299)	0.172 (0.753)
RUWNYMC	0.270 (0.759)	0.0996 (0.967)
FDWNYMC	-0.205 (-0.842)	-0.478 (-3.570)*
RET	0.00375 (6.048)	0.00261 (2.023)*
R2	0.381	0.839
DW	0.565	
RHO		-0.892 (-16.849)
OBS	78	77

*Indicates significance at 5%

2. Shipping Point-Wholesale Price Spread

The null hypothesis of symmetric pricing for fresh New York Red Delicious and fresh New York McIntosh apples was not rejected. The calculated t-statistics did not exceed the criterion of 1.671 and 1.675 respectively. Furthermore, the coefficients on both price increases and price decreases found in Table III.6 were insignificant at the 5% level suggesting that price increases and decreases at the shipping point level do not influence wholesale prices. The high t-ratios, 8.545 and 9.012, on **TRD** and the insignificance of **STOR** indicate that forces other than shipping point prices and marketing service costs could be more influential in determining wholesale prices for both New York Red Delicious and New York McIntosh apples.

These results suggest that the transmission of prices between the shipping point and wholesale levels of the market may be a weak link in the pricing structure of fresh New York Red Delicious and fresh McIntosh apples. In fact, prices may flow from wholesale to shipping points. Ward's study suggested that a concentrated wholesale market can influence prices at both the shipping point and retail levels in the fresh fruit and vegetable industries. Consequently, these results indicate more research is needed at the wholesale level to examine the direction of causality and the structure of the apple marketing and distribution system.

Table III.6
RESULTS OF THE PRICE SYMMETRY EQUATION FOR THE SHIPPING POINT-WHOLESALE PRICE SPREAD

NEW YORK RED DELICIOUS
DEPENDENT VARIABLE:WNYRDC

	OLS	FGLS
TRD	12.485 (12.557)	11.135 (8.545)*
RUFHVRD	0.261 (0.889)	0.311 (0.958)
FDFHVRD	0.680 (2.252)	0.216 (0.560)
STOR	-0.00078 (-2.846)	-0.00045 (-1.406)
R2	0.363	0.691
DW	0.924	
RHO		-0.761 (-7.959)
OBS	51	50

NEW YORK MCINTOSH
DEPENDENT VARIABLE:WNYMCC

	OLS	FGLS
TRD	12.555 (10.522)	13.434 (9.012)*
RUFNYMC	0.719 (1.896)	0.299 (0.630)
FDFNYMC	1.338 (1.716)	0.243 (0.292)
STOR	0.000161 (0.499)	-0.000045 (-0.120)
R2	0.098	0.369
DW	1.195	
RHO		-0.570 (-4.999)
OBS	57	56

*Indicates significance at 5%

3. Grower-Shipping Point Price Spread

Results reported in Table III.7 lead to a rejection of the null hypothesis that increasing and decreasing grower prices behave symmetrically in the market for New York Red Delicious apples. Hence, shipping point increases of New York Red Delicious apples respond differently to grower price increases and decreases. The results, indicate that both increasing grower prices (**RUUFP**) and decreasing grower prices (**FDDDFP**) are significant variables in determining shipping point prices. The data suggest that increasing grower prices impact shipping point prices by 0.615 cents per pound and that grower price decreases influence shipping point prices by 0.487 cents per pound. The coefficient on **IR** is negative and insignificant. This is not consistent with theoretical expectations. Because this interest rate variable acts only as a proxy for storage costs, however, it could be that the variable does not fully capture storage costs.

The results of estimation for the influence of grower price on the shipping point price of fresh New York McIntosh apples are not conclusive. The results indicate that only the trend variable drives the pricing structure for McIntosh apples. Also, signs inconsistent with economic theory are found on decreasing grower prices (**FDDDFP**) and on the **IR** variable.

Table III.7
RESULTS OF THE PRICE SYMMETRY EQUATION FOR THE GROWER -SHIPPING POINT PRICE SPREAD

NEW YORK RED DELICIOUS DEPENDENT VARIABLE:FHVRDC			NEW YORK MCINTOSH DEPENDENT VARIABLE:FNYMCC		
	OLS	FGLS		OLS	FGLS
TRD	0.241 (15.725)	0.257 (8.631)*	TRD	0.334 (15.410)	0.269 (6.324)*
RUUFP	0.790 (2.668)	0.615 (2.973)*	RUUFP	0.752 (1.804)	0.408 (1.936)
FDDDFP	0.0589 (0.331)	0.487 (2.401)*	FDDDFP	-0.214 (-0.831)	-0.317 (-1.502)
IR	-0.00114 (-1.032)	-0.00099 (-0.431)	IR	-0.00530 (-3.332)	-0.000041 (-0.015)
R2	0.129	0.772	R2	0.207	0.893
DW	0.578		DW	0.468	
RHO		-0.896 (-16.136)	RHO		-0.955 (-26.470)
OBS	69	68	OBS	72	71

*Indicates significance at 5%

4. Grower-Shipping Point Price Spread for Apple Juice

Results reported in Table III.8 indicate the test of price asymmetry for the grower-shipping point price spread of apple juice failed to accept the alternative hypothesis that price asymmetry exists at this market level.

Furthermore, both increases and decreases in grower prices are insignificant at the 5% level. The data suggest that increases and decreases in grower prices of apples do not influence the shipping point price of apple juice. This is consistent with negative coefficients on the increasing and decreasing price variables and the hypothesis that forces other than the price of processing apples drive the pricing structure of apple juice. In fact, positive significant coefficients on **TRD** and **IR** further support the aforementioned hypothesis.

Table III.8
RESULTS OF THE PRICE SYMMETRY EQUATION FOR THE GROWER-SHIPPING POINT PRICE SPREAD

JUICE
DEPENDENT VARIABLE:JUICE

	OLS	FGLS
TRD	5.377 (41.628)	5.380 (20.295)*
RUUFP	-1.456 (-2.169)	-0.566 (-0.862)
FDDDFP	-0.930 (-1.118)	-1.532 (-1.623)
IR	0.119 (10.727)	0.115 (4.895)*
R2	0.628	0.812
DW	0.915	
RHO		-0.730 (-9.322)
OBS	81	80

*Indicates significance at 5%

F. Price Transmission Elasticities

As in Kinnucan and Forker, price transmission elasticities were calculated at the mean for the wholesale-retail and the grower-shipping point price spreads to gain further insight into asymmetric price response behavior. Elasticities were not calculated for the shipping point-wholesale price spread because the null hypothesis of symmetric pricing for New York Red Delicious and McIntosh apples was not rejected at this market level and the results were not significant.

The elasticity of price transmission measures price responsiveness between market levels. For example, the price transmission elasticity (η) of the wholesale-retail price spread is defined as the responsiveness of retail price ($\mathbf{P_r}$) to a one percent change in the wholesale price ($\mathbf{P_w}$) as seen by

$$(III.1)\quad \eta = \frac{\delta Pr}{\delta Pw} * \frac{Pw}{Pr}$$

For the wholesale-retail price spread, the coefficients (**RUWNYR, RUWNYM**) in equations **II.20** and **II.21** represent the net effect of rising wholesale prices on retail price for New York Red Delicious, and New York McIntosh apples respectively. The coefficients (**FDWNYR, FDWNYM**) also in equations **II.20** and **II.21** represent the net effect of falling wholesale prices on retail price for New York Red Delicious and New York McIntosh apples. Similarly, the coefficients (**RUUFP, FDDDFP**) in equations **II.26** and **II.27** represent the net effect of rising and falling grower prices on shipping point prices of New York Red Delicious and New York McIntosh apples respectively.

As seen in Table III.9, retail price responsiveness to rising wholesale prices of New York Red Delicious apples, 0.450, was greater than retail price responsiveness to decreasing wholesale prices, 0.0833. This result confirmed earlier results which indicated that retail prices respond more significantly to wholesale price increases. The price transmission elasticities for New York McIntosh apples, however, are difficult to interpret as the coefficient on falling wholesale prices was of the wrong sign.

At the grower-shipping point price spread, the price transmission elasticities provided some insight into the results of the price asymmetry tests. For both New York Red Delicious and New York McIntosh apples, the null hypothesis of price asymmetry was accepted. In the case of Red Delicious apples, the coefficients on both rising and falling grower prices were significant. Calculation of the price transmission elasticities indicates that shipping point prices respond more fully to increases in grower prices, 0.404, than to decreases in grower prices, 0.320. For New York McIntosh apples, the coefficient of decreasing grower prices was again of the wrong sign making it difficult to interpret the price transmission elasticities.

Table III.9
PRICE TRANSMISSION ELASTICITIES FOR THE WHOLESALE-RETAIL AND GROWER-SHIPPING POINT PRICE SPREADS

WHOLESALE-RETAIL

VARIETY	WHOLESALE PRICES ARE	
	RISING	FALLING
Red Delicious	0.450	0.0833
McIntosh	0.0503	-0.242

GROWER-SHIPPING POINT

VARIETY	GROWER PRICES ARE	
	RISING	FALLING
Red Delicious	0.404	0.320
McIntosh	0.217	-0.168

G. Summary of Results

The model of the apple marketing and distribution system was estimated using **OLS**. Consistently low Durbin-Watson statistics indicated that the presence of autocorrelation, and the equations were re-estimated using **FGLS**. Inconsistent signs on the lagged price variables for all levels of the marketing system led to the rejection of a polynomial distributed lag specification. The equations were re-estimated with a distributed lag formulation. The estimation of the distributed lag structure indicated that monthly data lack sufficient periodicity to determine price lags for fresh apples.

Generally, tests for price asymmetry in the marketing system for fresh apples indicate that pricing asymmetry exists between the wholesale-retail and the grower-shipping point market levels. Moreover, the results indicate that retailers respond more fully to price increases than to price decreases and that the linkage between the wholesale and retail levels is extremely strong. These results are further supported by the price transmission elasticities. This suggests that consumers bear some of the burden of changing input costs.

In contrast, the results of price spread behavior for the shipping point-wholesale price spread indicate that wholesale price is not determined by shipping point price increases and decreases. This suggests a weak link in the price transmission process and that the direction of price flows assumed in this analysis many need further research. Finally, the results indicate that both grower price increases and decreases impact shipping point prices for New York Red Delicious apples. The results from the price transmission elasticities indicate, however, that shipping point prices may respond more fully to grower price increases.

Results for apple juice price spreads were unexpected and inconclusive. They indicate that grower price increases and decreases of apples may not influence shipping point prices of apple juice. Furthermore, negative coefficients on grower price variables and significant interest rate and trend variables suggest that forces outside United States apple production, namely, increasing imports and increasing efficiency in processing and marketing apple juice, are more significant in determining shipping point prices of apple juice.

SECTION IV. SUMMARY, CONCLUSIONS AND EXTENSIONS

A. Summary and Conclusions

The purpose of this study was to explain and model the price transmission processes of the U.S. apple marketing and distribution system. The apple marketing and distribution system can be explained as a function of grower price and three price spreads; the grower-shipping point price spread, the shipping point-wholesale price spread and the wholesale-retail price spread. As apples move through the system they are transformed through transportation, processing and distribution. The marketing process causes difficulties in assessing the relationship between prices at successive market levels. Additionally, price lags and asymmetric price transmission processes contribute to the uncertainty of how price changes at one market level affect prices at other market levels.

The markup model was chosen to represent price flows in the apple industry (Heien). Prices were assumed to flow from lower market levels to higher market levels. The factors of production and marketing service inputs were assumed to be used in fixed proportions. This assumption was supported by the fact that only a small amount of marketing inputs are required to market fresh apples, and the technology employed in processing apple juice is limited. Consequently, the opportunities of substitution between factors of production are restricted. Constant returns to scale in food processing technology was assumed based on the results of Wohlgenant's research. Finally, the industry was assumed to be competitive.

The price equation at each market level consisted of a price variable and a variable representing marketing costs. In the fresh apple market, the shipping point price of apples was expressed as a function of grower prices and the interest rate, a variable chosen to represent the opportunity costs that growers forego by placing their apples in storage. Wholesale price was expressed as a function of shipping point prices and a variable representing the level of trading between shipping point and wholesale levels. Retail price was expressed as a function of wholesale prices and an index chosen to represent the costs of retailing. Finally, the shipping point price of apple juice was specified as a function of grower prices and the opportunity costs of holding processing equipment. Apple juice was evaluated at only one level of the marketing system because of data limitations.

A data set of monthly time series was compiled from 1980 to 1990 using data published by the Agricultural Marketing Service, the U.S. Department of Agriculture, Bureau of Labor Statistics, other government sources and the Food Institute. The price series were not deflated because the purpose of this analysis was to examine the behavior on nominal and not real prices. Furthermore, different deflators are required for each market level making comparison between levels difficult.

The equations were originally estimated in **SAS** using Ordinary Least Squares (**OLS**) but consistently low Durbin-Watson statistics required the use of an autoregression correction procedure (**FGLS**).

Neither economic theory nor empirical evidence suggest an appropriate lag structure and lag length for the apple industry. Based on other studies of fresh fruits and vegetables (Ward) and the perishability of apples, a polynomial lag of degree two was chosen. Counterintuitive signs on the lagged price variables for all specified equations led to the rejection of the polynomial lagged structure. In order to more fully explore the role of price lags, the equations were re-estimated using a distributed lag formulation. The estimation of the distributed lag structure indicated that monthly data lack sufficient periodicity to determine price lags for fresh apples. It appears that lagged price transmission processes operating in the markets for fresh apples may lie somewhere between the current price and the price lagged one month. Generally strong positive t-ratios were estimated on both the current price variables and prices lagged one period. Furthermore, parameter estimates were unstable from sample to sample. High Pearson correlation coefficients suggested the presence of multicollinearity between price variables.

Results of the apple juice price spread were unexpected and inconclusive. Negative signs on the grower price coefficients were unanticipated. The markup model may be somewhat naive in representing the apple juice industry given the recent importance of apple juice imports.

The tests for asymmetric price response behavior are based on the estimation of the generalized equations as irreversible functions, where, price variables are divided into increasing and decreasing phases. Specified as irreversible functions, the coefficients on increasing and decreasing prices were used to test the null hypothesis that price increases and price decreases at lower market levels impact prices at higher market levels in the same manner.

As seen in Table IV.1 the results for the three market levels of New York Red Delicious and New York McIntosh apples indicate that increasing wholesale prices are a significant factor in determining retail prices. Furthermore, the price transmission elasticity at the wholesale-retail level for increasing wholesale prices was five times greater than the price transmission elasticity for decreasing prices.

These results suggest that retailers respond more fully to wholesale price increases for fresh apples, and that consumers bear the burden of changing input costs. This result has implications on apple pricing policy and grower welfare. Increasing costs at the wholesale level which are passed on to the consumer may disrupt the apple marketing system by reducing turnover as consumers move to purchase lower priced fruits. This in turn may harm growers as apple prices will eventually drop to alleviate the storage build up.

The results of price behavior for the wholesale-shipping point price spread were inconclusive. They indicate that wholesale price is not determined by shipping point price increases and decreases. This suggests a weak link in the price transmission process and that the direction of price flows assumed in this analysis may need further research. In this analysis, prices were assumed to flow from lower market levels to higher market levels following Heien's analysis. However, in Ward's analysis of fifteen fresh fruits and vegetables, Ward determined that in many instances, the wholesale market was a major pricing node which influenced both retail and shipping point prices. This possibility could be addressed in further research. In fact, extensive research concerning the use and importance of the wholesale market could be addressed for different markets. Much of the current literature on apples is about Washington apples. The literature suggests that the wholesale market is an important part of the apple marketing and distribution system. (McGary and Pearrow). However, How (1993) suggests that the importance of the wholesale market has declined in recent years as retail firms purchase their major fruit and vegetable items from shipping point sources and rely on the wholesale market for specialty items, prepared products and fill-in purchases.

Table IV.1
SUMMARY OF THE RESULTS FOR THE ASYMMETRIC PRICE RESPONSE EQUATIONS

WHOLESALE-RETAIL PRICE SPREAD

VARIETY	RISING PRICES	FALLING PRICES	TRD	RET
Red Delicious	1.166 (6.070)*	0.216 (1.119)	0.121 (0.589)	0.00291 (2.483)*
McIntosh	0.0996 (0.697)	-0.478 (-3.570)*	0.172 (0.753)	0.00261 (2.023)*

SHIPPING POINT-WHOLESALE PRICE SPREAD

VARIETY	RISING PRICES	FALLING PRICES	TRD	STOR
Red Delicious	0.311 (0.958)	0.216 (0.560)	11.135 (8.545)*	-0.00045 (-1.406)
McIntosh	0.299 (0.630)	0.243 (0.292)	13.434 (9.012)*	-0.00045 (-0.120)

GROWER-SHIPPING POINT PRICE SPREAD

VARIETY	RISING PRICES	FALLING PRICES	TRD	IR
Red Delicious	0.615 (2.973)*	0.487 (2.401)*	0.257 (8.631)*	-0.00099 (-0.431)
McIntosh	0.408 (1.936)	-0.317 (-1.502)	0.269 (6.324)*	-0.00041 (-0.015)
Juice	-0.566 (-0.862)	-1.532 (-1.623)	5.380 (20.295)*	0.115 (4.895)*

*Indicates significance at 5%.
NOTE: Numbers are the coefficients of price symmetry test developed in Section II. The numbers in parentheses are the ratio of the coefficient estimate to its standard error.

The results also indicate that both grower price increases and decreases impact shipping point prices for New York Red Delicious apples. Furthermore, the calculation of price transmission elasticities at the grower-shipping point level indicated that grower price increases influence shipping point prices more significantly that grower price decreases. The estimation for McIntosh apples yielded a negative coefficient on grower price decreases. These results suggest that differences in price transmission processes for different apple varieties may exist.

Finally, the results for the apple juice model strongly suggest that forces outside United States apple production, namely increasing imports and increasing efficiency in processing and marketing apple juice, are significant in determining shipping point prices of apple juice.

F. Future Directions and Extensions

If this study were to be improved, the next step would be to collect primary weekly data and re-estimate the model. The data collection could incorporate a disaggregated price series to better represent varieties other than Red Delicious apples. Furthermore, weekly data would allow further exploration of price lags for perishable commodities, and allow for a combination of a price lag and asymmetry equation. A combination of specifications could be tested to evaluate the role of both price lags and asymmetry in the apple marketing and distribution system.

In the case of apple juice, the markup model and data need further consideration. The model could be re-estimated with another variable, such as the quantity of apple juice imports, to test the impact of imports on apple juice prices.

In addition, the framework outlined in this analysis could be used to compare price transmission for several perishable commodities. This would allow for intraindustry comparisons of pricing structure, and the analysis of different pricing strategies. For example, the citrus industry currently uses marketing orders to regulate the amount of oranges on the market and the price of oranges. The apple industry has experimented with marketing orders, but a formal order has never been established. A study designed to compare the effectiveness of pricing strategy between the two industries may help the apple industry determine a pricing policy which is fair to both growers and consumers.

Finally, the markup model used in this analysis is quite restrictive. As mentioned previously, the model is confined by the assumption of causal price flows and the assumption that changes in only supply or demand influence price spreads. As discussed previously, the apple industry has experienced changes in both supply and demand over the last decade. In order to account for these changes, the price spreads of the apple industry could be modeled as relative price spreads as specified by Wohlgenant and Mullen in their modeling of the farm-retail price spread for beef. This specification differs from the markup model in that the relationship between the margin and retail price is not fixed, allowing for changes in both supply and demand. In other words, the marketing margin is specified as a function of retail price, the quantity of agricultural products marketed and the ratio of the costs of marketing inputs to retail price. Using the relative price spread specification may allow for a more flexible and accurate representation of the apple marketing system.

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APPENDIX 1
VARIABLE NAMES

DEPENDENT VARIABLES

RUS	Retail price of fresh apples in the U.S.
WNYRDC	Wholesale price of New York Red Delicious apples
WNYMCC	Wholesale price of New York McIntosh apples
FHVRDC	Shipping point price of Red Delicious apples
FNYMCC	Shipping point price of New York McIntosh apples
JUICE	Shipping point price of apple juice

PRICES USED IN ESTIMATING THE DISTRIBUTED LAG STRUCTURE

WNYRDC	Current wholesale price of New York Red Delicious apples
WNYRD1	Wholesale price of New York Red Delicious apples lagged one period
WNYMCC	Current wholesale price of New York McIntosh apples
WNYMC1	Wholesale price of New York McIntosh apples lagged one period
FHVRDC	Current shipping point price of New York Red Delicious apples
FHVRD1	Shipping point price of New York Red Delicious apples lagged one period
FNYMCC	Current shipping point price of New York McIntosh apples
FNYMC1	Shipping point price of New York McIntosh apples lagged one period
FP	Current price received by growers for fresh apples
FPPP1	Price received by growers for fresh apples lagged one period

PRICES USED IN TESTING FOR PRICE ASYMMETRY

RUWNYRD	Increasing wholesale price of New York Red Delicious apples
FDWNYRD	Decreasing wholesale price of New York Red Delicious apples
RUWNYMC	Increasing wholesale price of New York McIntosh apples
FDWNYMC	Decreasing wholesale price of New York McIntosh apples
RUFHVRD	Increasing shipping point price of New York Red Delicious apples
FDFHVRD	Decreasing shipping point price of New York Red Delicious apples
RUFNYMC	Increasing shipping point price of New York McIntosh apples
FDFNYMC	Decreasing shipping point price of New York McIntosh apples
RUUFP	Increasing price received by growers for fresh apples
FDDDFP	Decreasing price received by growers for fresh apples

VARIABLES REPRESENTING MARKETING COSTS

RET	Retailing costs
NYAT	Transportation rate per carton apples from New York to Atlanta
NYNYC	Transportation rate per carton apples from New York to New York City
STOR	Number of apples in storage facilities
IR	Opportunity cost of storage and processing equipment

APPENDIX 2
POLYNOMIAL LAGGED PRICE STRUCTURES[1]

WHOLESALE-RETAIL PRICE SPREAD

1. Wholesale Price Lags for New York Red Delicious Apples

WPNR0 = WNYRD + WNYRD1 * DUM1[2] + WNYRD2 * DUM2 + WNYRD3 * DUM3
+ WNYRD4 * DUM4
WPNR1 = WNYRD1 * DUM1 + 2 * WNYRD2 * DUM2 + 3 * WNYRD3 * DUM3
+ 4 * WNYRD4 * DUM4
WPNR2 = WNYRD1 * DUM1 + 4 * WNYRD2 * DUM2 + 9 * WNYRD3 * DUM3
+ 16 * WNYRD4 * DUM4

where:
WNYRD1 = wholesale price of New York Red Delicious apples lagged one period
WNYRD2 = wholesale price of New York Red Delicious apples lagged two periods
WNYRD3 = wholesale price of New York Red Delicious apples lagged three periods
WNYRD4 = wholesale price of New York Red Delicious apples lagged four periods

2. Wholesale Price Lags for New York McIntosh apples

WPNM0 = WNYMC + WNYMC1 * DUM1 + WNYMC2 * DUM2 + WNYMC3 * DUM3
+ WNYMC4*DUM
WPNM1 = WNYMC1 * DUM1 + 2 * WNYMC2 * DUM2 + 3 * WNYMC3 * DUM3
+ 4 * WNYMC4 * DUM4
WPNM2 = WNYMC1 * DUM1 + 4 * WNYMC2 * DUM2 + 9 * WNYMC3 * DUM3
+ 16 * WNYMC4 * DUM4

where:
WNYMC1 = wholesale price of New York McIntosh apples lagged one period
WNYMC2 = wholesale price of New York McIntosh apples lagged two periods
WNYMC3 = wholesale price of New York McIntosh apples lagged three periods
WNYMC4 = wholesale price of New York McIntosh apples lagged four periods

SHIPPING POINT-WHOLESALE PRICE SPREAD

1. Shipping Point Price Lags for New York Red Delicious Apples

FPRD0 = FHVRD + FHVRD1 * DUM1 + FHVRD2 * DUM2 + FHVRD3 * DUM3
+ FHVRD4 * DUM4
FPRD1 = FHVRD1 * DUM1 + 2 * FHVRD2 * DUM2 + 3 * FHVRD3 * DUM3
+ 4 * FHVRD4 * DUM4
FPRD2 = FHVRD1 * DUM1 + 4 * FHVRD2 * DUM2 + 9 * FHVRD3 * DUM3
+ 16 * FHVRD4 * DUM4

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[1]The empirical polynomial lagged structures defined in this appendix are derived from the theoretical development found in Section II.

[2]Dummy variables (DUM1, DUM2, DUM3 and DUM4) are used to deal with discontinuous time series and seasonal data. Further explanation can be found in Section II.

where:
FHVRD1 = shipping point price of New York Red Delicious apples lagged one period
FHVRD2 = shipping point price of New York Red Delicious apples lagged two periods
FHVRD3 = shipping point price of New York Red Delicious apples lagged three periods
FHVRD4 = shipping point price of New York Red Delicious apples lagged four periods

2. Shipping Point Price Lags for New York McIntosh Apples

FPMC0 = FNYMC + FNYMC1 * DUM1 + FNYMC2 * DUM2 + FNYMC3 * DUM3 + FNYMC4 * DUM4
FPMC1 = FNYMC1 * DUM1 + 2 * FNYMC2 * DUM2 + 3 * FNYMC3 * DUM3 + 4 * FNYMC4 * DUM4
FPMC2 = FNYMC1 * DUM1 + 4 * FNYMC2 * DUM2 + 9 * FNYMC3 * DUM3 + 16 * FNYMC4 * DUM4

where:
FNYMC1 = shipping point price of New York McIntosh apples lagged one period
FNYMC2 = shipping point price of New York McIntosh apples lagged two periods
FNYMC3 = shipping point price of New York McIntosh apples lagged three periods
FNYMC4 = shipping point price of New York McIntosh apples lagged four periods

GROWER-SHIPPING POINT PRICE SPREAD

1. Grower Price Lags for Fresh and Processed Apples

FPP0 = FP + FP1 * DUM1 + FP2 * DUM2 + FP3 * DUM3 + FP4 * DUM4
FPP1 = FP1 * DUM1 + 2* FP2 * DUM2 + 3 * FP3 * DUM3 + 4 * FP4 * DUM4
FPP2 = FP1 * DUM1 + 4 * FP2 * DUM2 + 9 * FP3 * DUM3 + 16 * FP4 * DUM4

where:
FP1= grower price lagged one period
FP2= grower price lagged two periods
FP3= grower price lagged three periods
FP4= grower price lagged four periods

APPENDIX 3
Data Tables and Sources of Data

Table 3.1 Price Variables

Source		g	d	d	d
Name		RUS ($/lb)	WWARD ($/42 lb)	WNYRD ($/42 lb)	WNYMC ($/42 lb)
OCT	1980	0.571	$12.95	$9.40	$10.60
NOV	1980	0.496	$12.31	$8.88	$10.50
DEC	1980	0.503	$12.75	$8.75	$10.25
JAN	1981	0.512	$12.56	$9.42	$10.38
FEB	1981	0.504	$13.13	$9.38	$10.88
MAR	1981	0.525	$13.50	$9.38	$10.97
APR	1981	0.529	$13.19	$9.31	$10.97
MAY	1981	0.531	$13.69	$9.13	$11.06
JUN	1981	0.546	$14.40	$9.25	$11.38
JUL	1981	0.577	$15.56	.	$11.38
AUG	1981	0.662	$21.80	.	.
SEP	1981	0.630	$23.00	.	.
OCT	1981	0.565	$18.00	$11.75	$13.75
NOV	1981	0.582	$18.50	$10.88	$14.35
DEC	1981	0.617	$19.06	$12.56	$16.38
JAN	1982	0.639	$19.31	$13.00	$8.69
FEB	1982	0.645	$20.53	$12.67	$17.25
MAR	1982	0.648	$20.80	$12.65	$17.55
APR	1982	0.630	$19.28	$12.83	$17.88
MAY	1982	0.667	$19.81	$12.50	$18.50
JUN	1982	0.722	$20.50	.	.
JUL	1982	0.733	$20.13	.	.
AUG	1982	0.683	$17.65	.	.
SEP	1982	0.627	$17.38	.	$9.17
OCT	1982	0.580	$15.38	$8.75	$9.25
NOV	1982	0.537	$14.95	$9.35	$9.15
DEC	1982	0.556	$15.34	$8.83	$9.50
JAN	1983	0.545	$14.60	$8.95	$9.80
FEB	1983	0.538	$15.19	$9.67	$10.63
MAR	1983	0.532	$15.00	$9.63	$10.63
APR	1983	0.559	$15.31	$9.56	$10.63
MAY	1983	0.584	$16.10	$10.15	$11.65
JUN	1983	0.615	$16.75	$10.75	$12.63
JUL	1983	0.622	$16.75	.	.
AUG	1983	0.673	$18.60	.	.
SEP	1983	0.707	$19.67	.	.
OCT	1983	0.574	$14.50	$9.17	$13.17
NOV	1983	0.562	$14.50	$9.94	$13.75
DEC	1983	0.568	$15.88	$9.75	$13.81
JAN	1984	0.579	$16.00	$9.33	$14.15

Table 3.1 Price Variables (continued)

Source	g	d	d	d
Name	RUS ($/lb)	WWARD ($/42 lb)	WNYRD ($/42 lb)	WNYMC ($/42 lb)
FEB 1984	0.608	$17.00	$10.50	$14.50
MAR 1984	0.640	$17.13	$10.56	$14.50
APR 1984	0.644	$17.00	$11.00	$14.65
MAY 1984	0.645	$17.50	$11.00	$15.00
JUN 1984	0.682	$17.13	.	.
JUL 1984	0.712	$18.50	.	.
AUG 1984	0.732	$19.06	.	.
SEP 1984	0.717	$19.13	.	.
OCT 1984	0.635	$19.10	$10.20	$11.70
NOV 1984	0.651	$19.50	$10.25	$12.69
DEC 1984	0.636	$19.25	$10.63	$14.13
JAN 1985	0.654	$18.50	$9.88	$13.35
FEB 1985	0.676	$20.00	$10.13	$12.69
MAR 1985	0.677	$20.63	$10.50	$12.75
APR 1985	0.695	$21.60	$10.63	$13.00
MAY 1985	0.710	$20.88	$11.50	$13.63
JUN 1985	0.723	$22.38	.	$14.19
JUL 1985	0.721	$23.00	.	.
AUG 1985	0.705	$19.13	.	.
SEP 1985	0.671	$22.75	$11.25	$12.00
OCT 1985	0.639	$19.50	$11.83	$12.13
NOV 1985	0.665	$20.00	$10.63	$12.06
DEC 1985	0.675	$19.90	$10.10	$12.70
JAN 1986	0.689	$18.94	$10.33	$13.75
FEB 1986	0.727	$20.04	$10.13	$15.61
MAR 1986	0.720	$20.67	$11.20	$15.45
APR 1986	0.728	$20.38	$11.90	$15.50
MAY 1986	0.770	$24.58	$13.31	$15.88
JUN 1986	0.830	$25.50	$13.50	$10.75
JUL 1986	0.859	$25.57	.	.
AUG 1986	1.015	$34.63	.	.
SEP 1986	0.925	$23.72	$14.50	$15.11
OCT 1986	0.691	$18.06	$12.67	$15.21
NOV 1986	0.665	$17.00	$10.92	$14.65
DEC 1986	0.662	$16.38	$10.27	$14.88
JAN 1987	.	$18.35	$12.70	$15.47
FEB 1987	.	$14.53	$12.75	$15.92
MAR 1987	0.741	$14.72	$12.69	$15.43
APR 1987	0.750	$19.95	$13.08	$15.46
MAY 1987	0.783	$21.40	$13.00	$15.75
JUN 1987	0.862	$23.90	$14.47	$14.13
JUL 1987	0.884	$23.63	$13.50	.
AUG 1987	0.815	$22.67	.	.

Table 3.1 Price Variables (continued)

Source		g	d	d	d
Name		RUS ($/lb)	WWARD ($/42 lb)	WNYRD ($/42 lb)	WNYMC ($/42 lb)
SEP	1987	0.729	$20.22	.	.
OCT	1987	0.618	$14.29	$14.00	$13.83
NOV	1987	0.546	$13.17	$9.93	$14.57
DEC	1987	0.547	$13.13	$8.89	$14.78
JAN	1988	0.571	$13.53	$10.25	$14.88
FEB	1988	0.636	$15.20	$9.75	$15.13
MAR	1988	0.635	$17.00	$8.00	$15.33
APR	1988	0.643	$16.88	$9.00	$15.50
MAY	1988	0.643	$16.50	$7.00	$16.87
JUN	1988	0.689	$16.63	.	$17.83
JUL	1988	0.797	$25.75	.	.
AUG	1988	1.006	$31.80	.	.
SEP	1988	0.957	$31.30	.	.
OCT	1988	0.768	$21.80	$9.54	$15.35
NOV	1988	0.704	.	$9.00	.
DEC	1988	0.706	$15.80	$8.81	$13.00
JAN	1989	0.729	$17.42	$12.00	$14.35
FEB	1989	0.749	$20.30	$11.81	$13.19
MAR	1989	0.741	$17.62	$11.81	$12.38
APR	1989	0.697	$16.98	$11.63	$16.31
MAY	1989	0.697	$16.24	$10.00	$17.32
JUN	1989	0.692	$16.13	$10.00	$17.25
JUL	1989	0.682	$16.30	.	.
AUG	1989	0.740	$17.45	.	.
SEP	1989	0.719	$18.50	.	$16.33
OCT	1989	0.649	$15.08	$7.00	$14.99
NOV	1989	0.590	$12.65	$7.00	$14.61
DEC	1989	0.573	$12.35	$7.00	$15.38
JAN	1990	0.601	$13.36	$6.40	$15.77
FEB	1990	0.632	$15.13	$7.21	$16.63
MAR	1990	0.652	$14.88	$7.00	$15.79
APR	1990	0.650	$15.00	.	$16.77
MAY	1990	0.653	$14.50	.	$16.58
JUN	1990	0.697	$14.88	.	$18.00
JUL	1990	0.750	$18.60	.	.
AUG	1990	0.832	$20.38	.	.
SEP	1990	0.877	$22.98	.	$17.00
OCT	1990	0.765	$18.90	$10.25	$15.08
NOV	1990	0.741	$19.10	$9.50	$15.46
DEC	1990	0.772	$20.50	$10.00	$16.13

Table 3.1 Price Variables (continued)

Source		c	c	a	e
Name		FHVRD ($/42 lb)	FNYMC ($/42 lb)	JUICE ($/12/32 oz)	FP ($/lb)
OCT	1980	$10.00	$8.75	.	0.125
NOV	1980	$8.86	$9.30	.	0.115
DEC	1980	$8.41	$9.19	.	0.107
JAN	1981	$8.27	$9.03	.	0.107
FEB	1981	$8.61	$9.69	.	0.124
MAR	1981	$8.67	$9.19	.	0.121
APR	1981	$8.47	$9.38	.	0.113
MAY	1981	$8.75	$9.50	.	0.107
JUN	1981	.	.	.	0.105
JUL	1981	.	.	.	0.127
AUG	1981	.	.	.	0.146
SEP	1981	.	.	.	0.160
OCT	1981	.	.	.	0.160
NOV	1981	$10.04	$12.13	.	0.161
DEC	1981	$11.38	$13.06	.	0.157
JAN	1982	$11.68	$14.15	$7.33	0.141
FEB	1982	$13.05	$14.56	$7.45	0.157
MAR	1982	$12.39	$14.88	$7.50	0.160
APR	1982	$11.25	$15.45	$7.45	0.145
MAY	1982	.	.	$7.28	0.162
JUN	1982	.	.	$7.28	0.177
JUL	1982	.	.	$7.38	0.153
AUG	1982	.	.	$7.38	0.128
SEP	1982	.	.	$7.50	0.163
OCT	1982	$7.81	$8.13	$6.88	0.145
NOV	1982	$7.39	$7.91	$6.88	0.139
DEC	1982	$7.16	$8.09	$6.75	0.130
JAN	1983	$7.64	$8.50	$6.80	0.110
FEB	1983	$9.11	$9.31	$6.80	0.122
MAR	1983	$8.72	$9.31	$6.80	0.120
APR	1983	$8.41	$9.43	$6.80	0.113
MAY	1983	.	.	$6.80	0.119
JUN	1983	.	.	$6.70	0.111
JUL	1983	.	.	$6.80	0.120
AUG	1983	.	.	$6.80	0.160
SEP	1983	.	.	$6.80	0.159
OCT	1983	.	$11.67	$6.50	0.149
NOV	1983	$9.63	$11.81	$6.50	0.146
DEC	1983	$9.71	$11.95	$6.50	0.140
JAN	1984	$9.41	$12.00	$6.50	0.143
FEB	1984	$9.64	$12.69	$6.38	0.151
MAR	1984	$9.40	$12.75	$6.38	0.152
APR	1984	$9.13	$12.78	.	0.148

Table 3.1 Price Variables (continued)

Source		c	c	a	e
Name		FHVRD ($/42 lb)	FNYMC ($/42 lb)	JUICE ($/12/32 oz)	FP ($/lb)
MAY	1984	.	.	$7.30	0.150
JUN	1984	.	.	.	0.146
JUL	1984	.	.	.	0.149
AUG	1984	.	.	$6.65	0.165
SEP	1984	.	.	.	0.185
OCT	1984	$10.25	$10.32	.	0.174
NOV	1984	$11.00	$10.66	$7.15	0.164
DEC	1984	$10.12	$11.85	$7.15	0.156
JAN	1985	$8.86	$12.34	.	0.140
FEB	1985	$9.19	$13.39	.	0.143
MAR	1985	$9.38	$11.68	.	0.157
APR	1985	$9.75	$13.06	.	0.151
MAY	1985	.	.	.	0.141
JUN	1985	.	.	.	0.131
JUL	1985	.	.	.	0.126
AUG	1985	.	.	.	0.121
SEP	1985	.	.	.	0.164
OCT	1985	$10.00	$10.22	.	0.154
NOV	1985	$9.35	$10.71	.	0.164
DEC	1985	$9.50	$11.25	.	0.166
JAN	1986	$10.50	$12.03	$6.83	0.166
FEB	1986	$11.08	$13.14	$6.83	0.172
MAR	1986	$10.22	$13.89	$6.38	0.172
APR	1986	$10.25	$13.99	$6.25	0.172
MAY	1986	$10.34	$14.00	$5.88	0.207
JUN	1986	.	.	$5.88	0.210
JUL	1986	.	.	$5.88	0.285
AUG	1986	.	.	$6.00	0.276
SEP	1986	.	$12.75	$6.50	0.209
OCT	1986	.	$12.81	$6.63	0.180
NOV	1986	$10.50	$13.05	$6.63	0.173
DEC	1986	$10.00	$13.21	$6.70	0.165
JAN	1987	$11.33	$13.78	$6.75	0.183
FEB	1987	$11.75	$14.06	$6.47	0.190
MAR	1987	$11.60	$14.08	$6.47	0.180
APR	1987	$11.28	$13.63	$6.47	0.191
MAY	1987	$12.08	$13.75	$6.25	0.224
JUN	1987	.	.	$6.38	0.246
JUL	1987	.	.	$6.35	0.255
AUG	1987	.	.	$6.35	0.152
SEP	1987	.	$11.50	$6.35	0.148
OCT	1987	.	$11.86	$6.28	0.121
NOV	1987	$9.31	$12.25	$6.40	0.113

Table 3.1 Price Variables (continued)

Source		c	c	a	e
Name		FHVRD ($/42 lb)	FNYMC ($/42 lb)	JUICE ($/12/32 oz)	FP ($/lb)
DEC	1987	$8.25	$12.35	$6.63	0.104
JAN	1988	$9.11	$13.03	$6.63	0.111
FEB	1988	$10.00	$13.27	$6.63	0.129
MAR	1988	$10.70	$13.44	$6.50	0.125
APR	1988	$10.00	$13.73	$6.50	0.110
MAY	1988	.	.	$6.13	0.109
JUN	1988	.	.	$6.00	0.104
JUL	1988	.	.	$6.38	0.228
AUG	1988	.	.	$6.63	0.277
SEP	1988	.	$13.67	$6.63	0.237
OCT	1988	$12.83	$14.32	$6.63	0.185
NOV	1988	$11.50	$14.00	$6.63	0.175
DEC	1988	$11.50	$14.05	$6.50	0.174
JAN	1989	$11.25	$14.50	$6.60	0.181
FEB	1989	$12.00	$15.25	$6.60	0.180
MAR	1989	$11.84	$15.02	$6.60	0.166
APR	1989	$10.25	$14.33	$6.60	0.144
MAY	1989	.	.	$6.60	0.135
JUN	1989	.	.	$6.70	0.108
JUL	1989	.	.	$6.70	0.115
AUG	1989	.	.	$6.70	0.159
SEP	1989	.	$12.50	$6.70	0.168
OCT	1989	$9.67	$12.58	$6.50	0.143
NOV	1989	$8.50	$12.58	$6.50	0.133
DEC	1989	$9.00	$13.04	$6.50	0.121
JAN	1990	$9.10	$13.87	$6.50	0.123
FEB	1990	$9.44	$14.38	$6.50	0.124
MAR	1990	$9.25	$14.42	$6.50	0.124
APR	1990	$9.25	$14.42	$6.50	0.121
MAY	1990	.	.	$6.50	0.126
JUN	1990	.	.	$6.50	0.123
JUL	1990	.	.	$6.25	0.184
AUG	1990	.	.	$6.25	.
SEP	1990	.	$14.08	$6.25	.
OCT	1990	$11.50	$13.83	$6.42	.
NOV	1990	$11.63	$13.46	$6.42	.
DEC	1990	$12.00	$13.68	$6.42	.

Table 3.2 Marketing Index Variables

Source		e	e	b	b	f
Name		NYAT ($/42 lb)	NYNYC ($/42 lb)	RET ($)	IR (%)	STOR (1000 lbs)
OCT	1980	1.00	0.58	149.10	14.000	4366
NOV	1980	1.25	0.58	150.60	16.125	4019
DEC	1980	1.25	0.58	152.20	19.625	3244
JAN	1981	1.30	0.58	152.81	20.750	2635
FEB	1981	1.30	0.58	153.92	19.500	2035
MAR	1981	1.30	0.58	154.96	18.250	1486
APR	1981	1.17	0.58	156.60	17.500	996
MAY	1981	1.17	0.58	156.38	19.250	553
JUN	1981	.	.	158.99	20.250	184
JUL	1981	.	.	161.92	20.250	84
AUG	1981	.	.	162.23	20.500	16
SEP	1981	.	.	162.17	20.000	1424
OCT	1981	1.17	0.53	157.94	18.750	3871
NOV	1981	1.17	0.53	159.13	17.000	3332
DEC	1981	1.17	0.53	160.89	15.750	2676
JAN	1982	1.22	0.47	157.47	15.750	2128
FEB	1982	1.17	0.53	159.35	16.375	1648
MAR	1982	1.11	0.53	159.64	16.500	1119
APR	1982	1.11	0.53	161.02	16.500	.
MAY	1982	1.11	0.53	163.01	16.500	.
JUN	1982	.	.	164.65	16.500	265
JUL	1982	.	.	168.24	16.000	.
AUG	1982	.	.	168.24	14.500	.
SEP	1982	.	.	166.70	13.500	1500
OCT	1982	1.11	0.53	165.39	12.750	.
NOV	1982	1.11	0.53	165.43	11.750	.
DEC	1982	1.11	0.53	168.97	11.500	3082
JAN	1983	1.06	0.53	164.98	11.250	2446
FEB	1983	1.11	0.53	163.30	10.750	1892
MAR	1983	1.11	0.53	166.42	10.500	1321
APR	1983	1.14	0.66	167.29	10.500	853
MAY	1983	1.11	0.66	169.59	10.500	426
JUN	1983	.	.	171.87	10.500	216
JUL	1983	.	.	175.03	10.500	68
AUG	1983	.	.	174.16	10.750	11
SEP	1983	.	.	172.52	11.000	1750
OCT	1983	.	.	173.40	11.000	3929
NOV	1983	.	.	172.84	11.000	3773
DEC	1983	.	.	178.02	11.000	2980
JAN	1984	1.25	0.58	173.17	11.000	2460
FEB	1984	.	0.61	173.17	11.000	1887
MAR	1984	.	0.61	174.34	11.250	1354
APR	1984	.	0.61	175.82	11.750	912

Table 3.2 Marketing Index Variables (continued)

Source		e	e	b	b	f
Name		NYAT ($/42 lb)	NYNYC ($/42 lb)	RET ($)	IR (%)	STOR (1000 lbs)
MAY	1984	.	.	176.40	12.250	396
JUN	1984	.	.	178.75	12.750	237
JUL	1984	.	.	180.21	13.000	.
AUG	1984	.	.	178.70	13.000	.
SEP	1984	.	.	177.29	12.875	.
OCT	1984	.	0.58	174.93	12.375	.
NOV	1984	.	0.58	175.82	11.625	.
DEC	1984	.	0.58	179.65	11.000	.
JAN	1985	.	0.53	173.73	10.625	2464
FEB	1985	.	0.53	174.31	10.500	1858
MAR	1985	.	0.53	175.52	10.500	1372
APR	1985	.	0.53	175.22	10.500	910
MAY	1985	.	0.53	177.91	10.250	485
JUN	1985	.	.	179.39	9.750	291
JUL	1985	.	.	180.27	9.500	131
AUG	1985	.	.	179.07	9.500	34
SEP	1985	.	.	177.90	9.500	1712
OCT	1985	1.03	0.53	175.52	9.500	3668
NOV	1985	1.03	0.55	176.09	9.500	3342
DEC	1985	1.03	0.55	178.50	9.500	2724
JAN	1986	1.03	0.55	173.06	9.500	2125
FEB	1986	1.03	0.55	172.74	9.500	1550
MAR	1986	1.03	0.55	174.27	9.250	1039
APR	1986	1.03	0.55	173.69	8.750	612
MAY	1986	1.03	0.55	174.60	8.500	266
JUN	1986	.	.	176.71	8.500	118
JUL	1986	.	.	178.50	8.250	25
AUG	1986	.	.	178.50	7.750	7
SEP	1986	.	0.58	176.66	7.500	2349
OCT	1986	.	0.58	175.76	7.500	4142
NOV	1986	1.25	0.58	176.06	7.500	3532
DEC	1986	1.25	0.58	178.46	7.500	2891
JAN	1987	1.25	0.58	172.35	7.500	2307
FEB	1987	1.25	0.58	174.78	7.500	1720
MAR	1987	1.25	0.58	175.71	7.500	1174
APR	1987	1.25	0.58	177.83	7.750	751
MAY	1987	1.25	0.58	177.83	8.125	386
JUN	1987	.	.	177.83	8.250	203
JUL	1987	.	.	179.97	8.250	74
AUG	1987	.	.	182.10	8.250	4
SEP	1987	.	.	183.31	8.500	2687
OCT	1987	1.25	0.58	182.90	9.000	5390
NOV	1987	1.25	0.58	179.26	8.875	4697

Table 3.2 Marketing Index Variables (continued)

Source		e	e	b	b	f
Name		NYAT ($/42 lb)	NYNYC ($/42 lb)	RET ($)	IR (%)	STOR (1000 lbs)
DEC	1987	1.25	0.58	179.22	8.750	3311
JAN	1988	.	0.58	176.59	8.750	3158
FEB	1988	.	0.58	177.56	8.625	2417
MAR	1988	.	0.58	178.46	8.500	1584
APR	1988	.	0.58	180.91	8.500	.1093
MAY	1988	.	0.58	181.49	8.750	552
JUN	1988	.	.	184.04	9.000	248
JUL	1988	.	.	188.40	9.250	94
AUG	1988	.	.	186.55	9.750	5
SEP	1988	.		184.73	10.00	1857
OCT	1988	.	.	185.95	10.00	4601
NOV	1988	.	.	185.47	10.25	3904
DEC	1988	.	.	190.33	10.50	3265
JAN	1989	1.25	0.58	184.03	10.50	2659
FEB	1989	1.25	0.58	183.10	11.00	2099
MAR	1989	1.25	0.58	184.68	11.50	1545
APR	1989	1.25	0.58	188.43	11.50	1069
MAY	1989	.	.	186.91	11.50	619
JUN	1989	.	.	189.51	11.25	347
JUL	1989	.	.	194.05	10.75	174
AUG	1989	.	.	192.40	10.50	7
SEP	1989	.	.	191.03	10.50	2260
OCT	1989	1.25	0.58	191.32	10.50	4468
NOV	1989	1.25	0.58	189.90	10.50	3852
DEC	1989	1.25	0.58	194.47	10.50	3220
JAN	1990	1.25	0.58	189.11	10.25	.
FEB	1990	1.25	0.58	190.18	10.00	.
MAR	1990	1.25	0.58	192.09	10.00	.
APR	1990	1.25	0.58	195.75	10.00	.
MAY	1990	.	.	194.40	10.00	.
JUN	1990	.	.	197.78	10.00	.
JUL	1990	.	.	200.18	10.00	.
AUG	1990	.	.	198.45	10.00	.
SEP	1990	.	.	197.97	10.00	.
OCT	1990	1.25	0.58	194.54	10.00	.
NOV	1990	1.25	0.58	194.82	10	.
DEC	1990	1.25	0.58	199.73	10	.

Table 3.3 Data Sources

a	American Institute of Food Distribution Inc. *The Food Institute Report.* Selected Issues.
b	U.S. Bureau of Economic Analysis, *Survey of Current Business.* Selected Issues.
c	U.S. Department of Agriculture, Agricultural Marketing Services, "Marketing New York State Apples", Yearly Issues: 1980-1990.
d	U.S. Department of Agriculture, Agricultural Marketing Services, New York City Fresh Fruit Vegetable Wholesale Market Prices, Yearly Issues:1980-1990.
e	U.S. Department of Agriculture, Economic Research Service. *Fruit and Tree Nuts Situation and Outlook Report.* Selected Issues.
f	U.S. Department of Agriculture, *Cold Storage Reports*, Washington, D.C. Selected Issues.
g	U.S. Department of Labor, Bureau of Labor Statistics, "Retail Apple Prices" computer runs Jan 1980-July 1991.

OTHER AGRICULTURAL ECONOMICS RESEARCH PUBLICATIONS

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